Compressed Air Magazine

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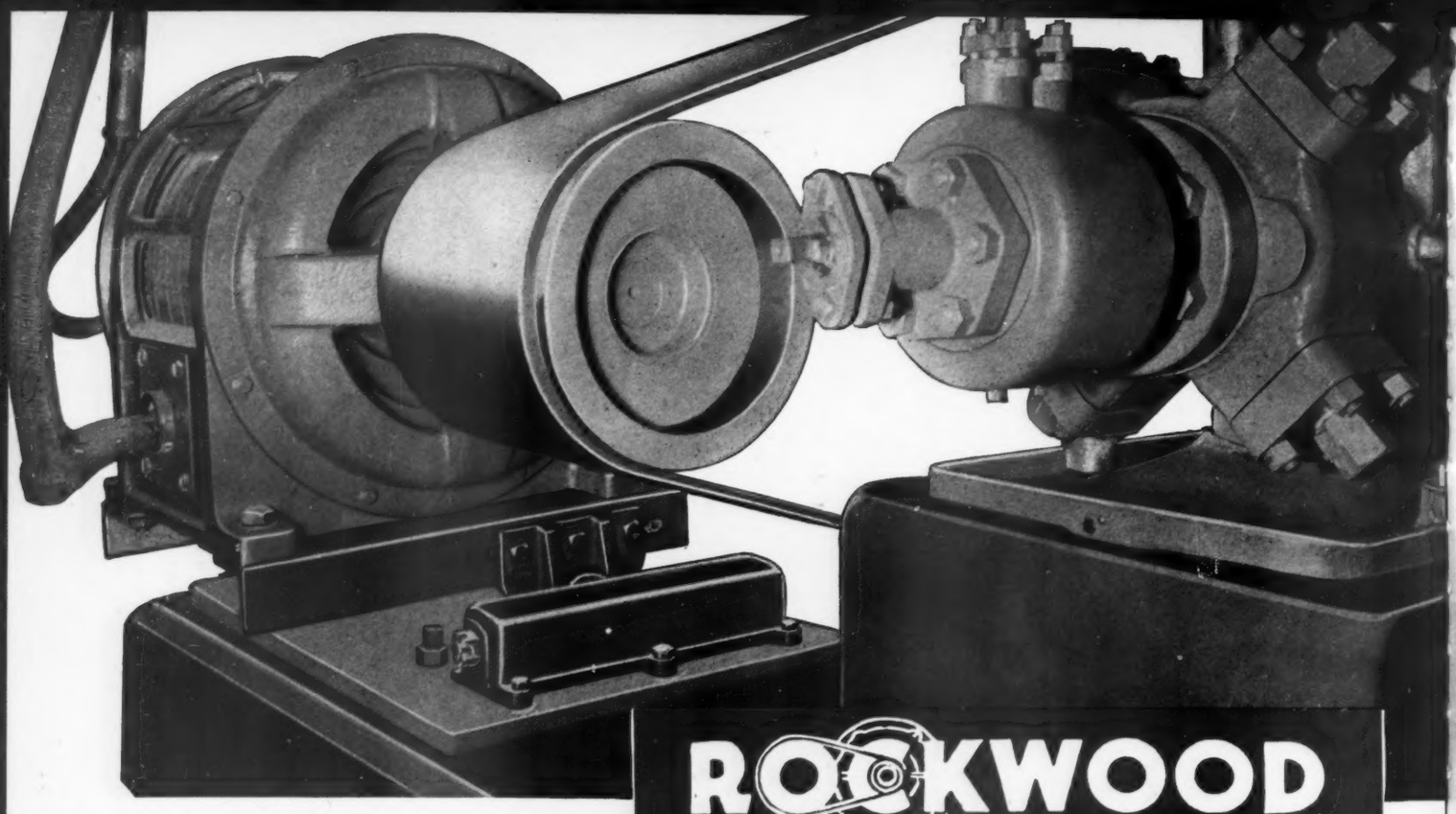
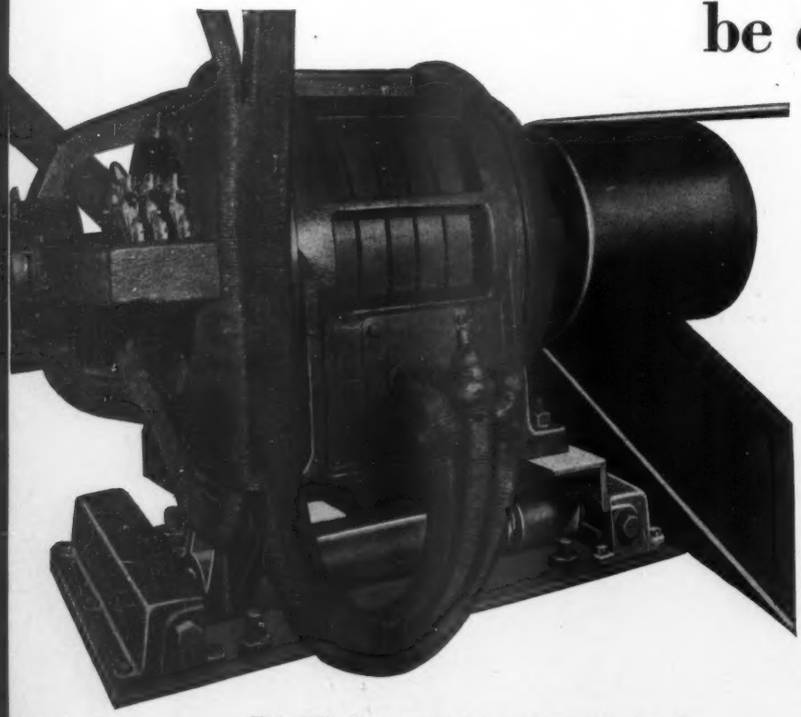
DRILLING ON THE PENNSYLVANIA TURNPIKE



In Loew's Delancey Theater, New York City, is this 125 h.p. motor driving 110 ton compressor with Rockwood pivoted-motor Drive. As the compressor was running when picture was taken you can observe the characteristic absence of vibration.

ROCKWOOD PIVOTED MOTOR DRIVE

IN THEATERS compressors must be *dependable* and *quiet*



This 150 h.p. motor drives the compressor in Loew's Boston Road Theater, Bronx, New York City. With the Rockwood Drive their cooling system is dependable, service is continuous and the drive operates with an economy and efficiency possessed by no other short center belted drive.

In theaters compressors must be *quiet, economical* and *dependable* for they run for long periods and get but little attention. That is why so many theaters have chosen Rockwood pivoted-motor Drives for their compressors. *Reliability and continuity of service are unquestioned.* Compressor performance is improved, operating costs are reduced and belt life is greatly increased.

Rockwood Drives may be used with either flat belts or V-belts and will increase the efficiency of either. Belt replacement often is cut in half—power is saved—and the drives run with a freedom from attention and annoyance that makes them extremely well liked.

When belts on fixed center drives stretch, the belt tension falls off, speeds of driven machines are reduced and belts slip—burn on the pulleys—and waste power. With the Rockwood pivoted-motor Base, part of the weight of the motor plus electric "kick back" of the motor is used, first to establish, and then to automatically maintain just the right amount of belt tension to handle the maximum load without belt slip. Belt stretch is taken up automatically, as it occurs—so expensive belt-slip is forever eliminated and power and belts are saved.

ROCKWOOD'S FREE TRIAL OFFER:

Any accredited theater can secure a Rockwood Base on trial for any size motor, try it out for any reasonable period, and if the drive is not satisfactory we won't want them to keep it. WRITE FOR A ROCKWOOD REPRESENTATIVE TO CALL. Change over your old drives to Rockwood pivoted Drives and get more satisfactory service and at less operating cost. Any motor does better work when it has a Rockwood pivoted base under it.—

ROCKWOOD MANUFACTURING CO., INDIANAPOLIS, IND.

ROCKWOOD V-BELTS AND V-SHEAVES ROCKWOOD PIVOTED-MOTOR DRIVES

ROCKWOOD PAPER PULLEYS

ON THE COVER

OUR cover picture shows an FM-2 wagon drill working in Fulton County, Pennsylvania, on the new superhighway that is described in our first article. This type of drill will put down holes to depths of 20 feet, and is exceptionally well suited for the heavy excavating that this undertaking involves. The view is of a section of a 5.5-mile grading contract being carried out by L. M. Hutchison Company of Mount Union, Pa.

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IN THIS ISSUE

THE Pennsylvania Turnpike is without question the most ambitious roadbuilding enterprise ever projected in this country. It will compare favorably in width, grade, safety features, and ease of driving with the extensive system of high-speed *Autobahnen* built in Germany during recent years. Moreover, the terrain it will traverse is far more rugged than that over which the German highways run. To obtain a roadway of low grades under the existing conditions calls for gigantic cuts and fills, not to mention the penetration of seven mountain ranges by tunnels. Our current article describes the general features of the turnpike. A later one will give a more detailed account of how some of the construction operations are being conducted.

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ALTHOUGH Jackbits are relatively new tools in the hands of rock drillers, they already present a field for specialization. All mines and other enterprises concerned with breaking rock are keenly interested in anything that makes it possible to drill a larger number of holes per shift. Drilling machines have been speeded up greatly in recent years, with the result that it is becoming more and more difficult to better performances. Therefore, it is only natural that closer attention should be given to the improvement of bits with a view to increasing drilling efficiency. Already a number of special bits have been developed to cope with unusual drilling problems; and their success has intensified the study of the effect of bit modifications. An article in this issue treats of this trend.

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SALMON persist in heeding the instinctive urge to seek their breeding grounds in the headwaters of streams for spawning. Accordingly, man must plan so that structures thrown across the rivers of our Northwest will permit this important food and game fish to follow its natural bent. Means incorporated in Bonneville Dam on the Columbia River to pass salmon and other fish safely up and down stream are proving highly successful; and the description of them by Robert G. Skerrett should prove of interest.

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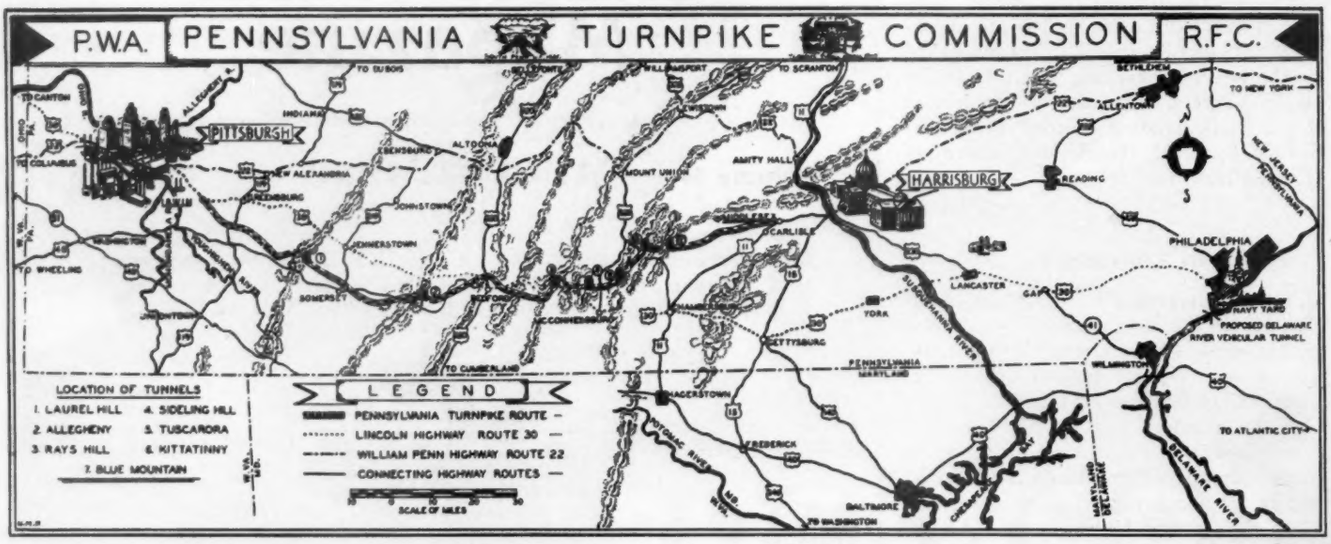
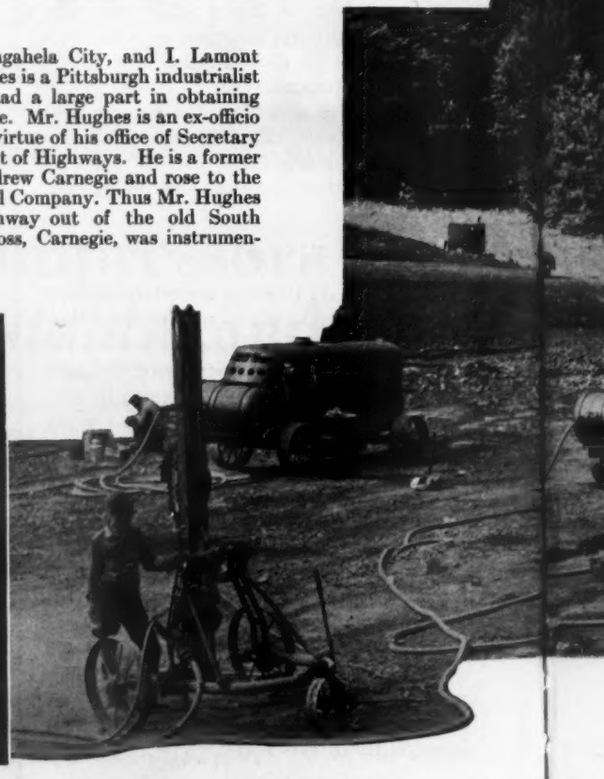
The Pennsylvania Turnpike

C. H. Vivian



TURNPIKE ROUTE AND COMMISSION

The map shows the relation of the superhighway to existing main roads. From Middlesex to Irwin the distance will be 161 miles. The turnpike will considerably shorten the travel time between Harrisburg and Pittsburgh, reduce the cost, and eliminate the hazards presented by the present winding roads with alternate steep climbs and descents. The tunnel sections will have an aggregate length of about 7 miles. The gentlemen pictured below are administering the expenditure of $61,100,000 for America's first superhighway. From left to right they are: Charles T. Carpenter of Glenmoor; Thomas J. Evans of Coaldale; Walter A. Jones of Pittsburgh, chairman; Frank Bebout of Monongahela City, and I. Lamont Hughes of Harrisburg. Mr. Jones is a Pittsburgh industrialist who is credited with having had a large part in obtaining Federal backing for the turnpike. Mr. Hughes is an ex-officio member of the commission by virtue of his office of Secretary of the Pennsylvania Department of Highways. He is a former steelman who started with Andrew Carnegie and rose to the presidency of the Carnegie Steel Company. Thus Mr. Hughes is helping to make a superhighway out of the old South Penn Railroad that his first boss, Carnegie, was instrumental in launching.



AMERICA'S first superhighway, the $61,100,000 PWA and RFC financed Pennsylvania Turnpike, is rapidly taking form. More than 6,000 men and millions of dollars worth of the most modern roadbuilding machinery are concentrated along a 161-mile stretch, carving a high-speed travel artery through the Allegheny Mountains that will be carrying traffic between Harrisburg and Pittsburgh in 1941. The tempo of construction activity is being quickened daily, and it is estimated that in another month or so 18,000 workmen will be on the payrolls of upwards of 75 contractors. Already, the last contract for grading and drainage has been let, work is underway on the driving of the seven tunnels incorporated in the route, and numerous contracts for paving the actual roadway and for erecting buildings to house tunnel-ventilating equipment have been awarded. When it is considered that less than ten months have elapsed since financing arrangements were completed, it will be seen that this project takes rank as one of the fastest-moving construction jobs that has ever been undertaken.

The turnpike route starts at Middlesex, 16 miles west of Harrisburg, and extends to Irwin, 21 miles east of Pittsburgh. First-class roads will form connecting links with Harrisburg at one end and Pittsburgh at the other. In general, the superhighway will follow the route of the old South Pennsylvania Railroad, on which work ceased in 1885 after $10,000,000 had been expended on it. The history of that unfinished enterprise was presented in our June, 1937, issue. To summarize it briefly,

CONSTRUCTION SCENE ON SOUTH PENN RAILROAD

The western portal of Rays Hill Tunnel, as it appeared in 1885 a short time before work was suspended on the $10,000,000 railroad that never ran a train. In the foreground, at the left of the tracks, is Andrew Carnegie, the Pittsburgh steel magnate who was reported to have backed the venture with $5,000,000. On the right side of the tracks is Carnegie's construction engineer, George Lauder, grandfather of the former Miss Polly Lauder who is the wife of James J. Tunney, former world heavyweight boxing champion.

STARTING A LARGE CUT

Three new Ingersoll-Rand streamlined, oil-engine-driven portable compressors and two Type FM-2 wagon drills being used by the Empire Construction Company of Baltimore, Md., on its contract for 5½ miles of grading in Bedford County.

the railroad was launched by New York Central interests to compete with the Pennsylvania System for the lucrative freight traffic of the Pittsburgh steel district. It was a retaliative move against the Pennsylvania's threat to build a line up the west shore of the Hudson River to compete with the New York Central's main artery from New York City towards the West. William H. Vanderbilt was the moving spirit behind the South Penn, and he had ample backing from Andrew Carnegie, who had long been at loggerheads with the Pennsylvania over the question of freight rates to and from his Pittsburgh steel mills. Hundreds of workmen poured into the hills in 1883, and by the summer of 1885 had established grade on 60 per cent of the route and excavated approximately 62 per cent of the nine tunnels that had an aggregate length of 37,389 feet. Foreseeing a long, bitter, and costly fight between the two railroads if the line were completed, J. P. Morgan interceded and forced Vanderbilt and his associates to sell the half-finished road to the Pennsylvania. The sale sounded the death knell for the South Penn. Work was abruptly ceased and never resumed. The right of way remained in the hands of the Pennsylvania and the Baltimore & Ohio railroads until its purchase last year by the turnpike authorities for $2,000,000.

The highway is being built by the Pennsylvania Turnpike Commission, a creation of the Commonwealth of Pennsylvania. The commission was appointed by the state general assembly on May 21, 1937, and was empowered to construct, operate, and maintain the route. It was given authority to issue Turnpike Revenue Bonds of the Commonwealth to finance the undertaking. The commission consists of five members, one of whom is the secretary of the Pennsylvania Department of Highways, which organization, the act provides,

shall approve and supervise the building of the turnpike. After unsuccessful efforts had been made to finance the highway with private funds, an appeal was made to the Federal Government. It became interested, partly because the road had military significance and partly because its construction would furnish employment for many persons. An outright grant of 45 per cent of the cost of the turnpike, not to exceed $26,100,000, was obtained from the Federal Emergency Administration of Public Works. The remainder of the estimated $61,100,000 has been raised by the sale of 3¾ per cent bonds to the Reconstruction Finance Corporation. These bonds, the receipts from which are being drawn upon as they are needed, are redeemable, in whole or in part, on or after August 1, 1947.

As the word turnpike implies, the highway will be operated on a toll basis. Studies made by the commission and by independent traffic engineers are the basis for the prediction that the cost of construction will be entirely repaid by 1954. When the bonds are amortized, the turnpike will become a part of the toll-free state highway system. Although toll rates have not been definitely fixed, it is likely that the average passenger car will pay $1.25 for a through trip, and trucks from $4 to $10. The latter charge will be for the heaviest trailer-type trucks, weighing from 30,000 to 62,000 pounds when loaded. Tolls for vehicles traveling less than the full length of the turnpike will range from one cent a mile for passenger cars to four cents for trucks.

The statistics which formed the basis for estimating toll rates indicated that 1,300,000 of the 3,500,000 vehicles that cross Pennsylvania each year can be expected to use the turnpike during its first year of operation, and that the number will grow to 2,070,000 by 1945. It is predicted that the revenue during the first year will be $2,670,000, and that it will increase annually and reach $4,000,000 in 1945. Various truck and bus operators have already signified their intention of using the superhighway, and admit that it will save them both time and money. For a heavy truck paying a $10 toll the saving is estimated at $27 a trip. At present, most heavy trucks traveling between New York and Chicago take Route 20 through New York, northern Pennsylvania, Ohio, and Indiana, thereby escaping heavy grades. As the turnpike will eliminate steep climbs in crossing the Alleghenies and provide a route 145 miles shorter than that now being used, the expectations are that a considerable percentage of the through haulage will utilize it.

Connecting, as it will, the steel-mill and manufacturing district of Pittsburgh with the rolling country east of the mountains and within easy reach of tidewater, the highway will be important as a measure of national defense. Recognizing this, the Government has stipulated that it be allowed the use of the roadway without payment of tolls in times of national emergency. Those primarily responsible for the turnpike are of the opinion that it will be the forerunner of an extensive system of superhighways throughout the country. They confidently expect that it will gain such favor with the public and prove so successful financially that links will be added to it comparatively soon. They are already laying plans to extend the route 112 miles into Philadelphia.

A few statistics should serve to impress the reader with the hugeness of the undertaking. The over-all cost per mile will be $279,000; and the total cost of $61,100,000 exceeds that of the entire road system in some states. Construction involves the excavation of 21,000,000 cubic yards of earth and rock. Of this amount, approximately 600,000 cubic yards will be removed in driving the tunnels. Materials that will be required include 2,000,000 barrels of cement, 700,000 tons of sand, 1,100,000 tons of stone, and 25,000 tons of steel.

Anyone who has driven an automobile across the length of Pennsylvania will not question the need for a more direct and more level highway. The Alleghenies cast themselves athwart the state in the form of seven major ridges running in a northeast-southwest direction, and the existing through roadways present a long succession of climbs and drops, with frequent curves and numerous steep slopes. The nearest paralleling route to the turnpike climbs a total of nearly 14,000 feet in the stretch from Harrisburg to Pittsburgh. The new superhighway will, by contrast, have an aggregate vertical ascent of only 3,940 feet. This saving of 10,000 feet will, it is conceded, reduce the cost of operating automotive vehicles, particularly trucks and buses; and it is from these heavier automobiles that the major portion of the income is expected.

For both commercial and pleasure cars, there will be an important saving in time by traveling the turnpike, and most of the drudgery and monotony of driving along existing routes will be removed. From the standpoint of safety, the new artery will prove decidedly advantageous. Even though high speeds will be permitted (no speed limit is contemplated at the present time, except in or near tunnels), the design of the turnpike is such as to eliminate the principal causes of accidents. So far as speed alone is concerned, studies reveal that only 9 per cent of all automobile accidents are attributable to speeds in excess of 50 miles an hour.

Except in the tunnels, the road will consist of 24-foot-wide, 2-lane, concrete surfaces for 2-way traffic, and of a separating 10-foot parkway. There will be a 10-foot shoulder on each side of fill sections, while the shoulders in cuts will be 7 feet wide, with 3-foot drainage ditches along their outer edges. In the tunnels, which will have a combined length of about 7 miles, there will be two 11½-foot traffic lanes. The maximum grade will be 3 per cent, as compared with grades as high as 9½ per cent on existing trunk-line highways. There will be only 176 curves in the 161 miles, and only ten of these will be sharper than 4°, with a 6° curvature the limit. There will be no sharp curves at the ends of gentle ones, and no sharp curves at the ends of long, straight stretches. At all points the roadway will be visible for at least 600 feet ahead. All curves will be

WIDENING OLD R. R. GRADE

The higher surface, at the right, is a part of the grade established for the South Penn Railroad. The new fill at the left is being built up to its level. More than half of the 37,000 feet of tunnels driven a half-century ago can be utilized in the new highway, but approximately 95 per cent of the line in the open will call for new construction. This picture was taken in Fulton County on the contract of C. J. Langenfelder & Son of Baltimore, Md.

elevated at their outer edges, the rate of rise varying in accordance with the sharpness of the curve. One-degree curves will have a normal super elevation of ⅛ inch per foot of width; 2° curves, ⅜ inch rise per foot; 3° curves, ¾ inch; 4° curves, 1 inch; and 5 and 6° curves, 1 3/16 inches. Because of these design features, it is expected that the curved sections can be driven safely at a speed only 5 miles an hour less than that on the straightaways.

There will be no grade crossings and no traffic lights, and all towns will be bypassed. Warning and directional signs will, so far as possible, be suspended overhead, making them easily visible and removing them from the sides of the highway, where they constitute hazards. Traffic will be able to enter or leave the turnpike at thirteen intermediate points. These entrances and egresses will be in the forms of cloverleafs that will eliminate all cross traffic. Extra lanes will be provided at either side of the roadway to enable entering cars to accelerate speed before joining the traffic stream and departing ones to decelerate before turning off. Property owners adjoining the highway will not be permitted to cross it except by established routes. The minimum right of way is 200 feet wide; and the prospects are that the commission will have control over all filling stations and other commercial structures along the turnpike. The commission will also provide its own police force.

The route generally follows the watershed between the Potomac and Susquehanna river valleys, and is, accordingly, on high ground. This will make excavation costs greater than they would be if the line were lower at some points; but fewer structures will be required, as the streams, while fairly numerous at higher levels, are small. Of the 139 drainage structures to be built, only 29 will be more than 25 feet in span and only fourteen more than 50 feet. The elevated line will also obviate any flood danger. In Bedford County, where the turnpike will descend into the Juniata River Valley, the grade will be 4 feet above the level of the highest recorded flood.

In its construction phases, the superhighway presents some truly spectacular operations. Aside from the tunnels, which will be used more extensively than ever before on any roadway in this country, cuts and fills are in some instances of almost unprecedented proportions. Indicatory of the heavy work that is involved is the fact that the average cost per mile for grading and drainage is $140,000, as compared with $25,000 for the average first-class highway built in Pennsylvania. The largest cut, which will also be the largest in the state, will be a gash through Clear Ridge Mountain near Everett. It will be 150 feet deep, 380 feet wide at the top, and 2,600 feet long, and will involve the removal of more than 1,100,000 cubic yards of rock and earth. Another cut in the same general area will be 106 feet deep and 800 feet long, and numerous others will far surpass in magnitude the biggest ordinarily found on mountain roadways. Fills will be of correspondingly huge dimensions, and many of them will be more than 100 yards thick at the bottom.

Only six of the nine tunnels that were partially excavated by the South Pennsylvania Railroad builders will be utilized. Near the western end of the line, an 83-foot cut 1,250 feet long will be substituted for Quemahoning Tunnel, and a 67-foot cut 1,500 feet long will be used instead of Negro Mountain Tunnel. The Allegheny Tunnel was found to be in such a bad condition that it was decided to drive a new paralleling one. In all other cases the old tunnels are being cleaned out and enlarged in section. They will then be driven to completion. The tunnels were started wide enough to carry two railroad tracks, but they narrow down to single-track width about 300 feet in from the portals, showing that a change in design had been made by the original builders after work was begun.

On either side of the 23-foot roadway in the tunnels there will be a walkway 2½ feet wide, making a clear width of 28 feet inside the reinforced-concrete lining which will vary from 12 to 18 inches in thickness, according to the character of the rock traversed. There will be 14 feet of headroom. All the tunnels will be ventilated to keep the concentration of carbon monoxide within safe limits. Fans housed in thirteen buildings to be erected over the tunnel portals will have sufficient capacity to send 175 cfm. of fresh air into the bores for every foot of their length. This will be introduced through ducts in the ceiling of each tunnel, while the vitiated air will be drawn out near the floor at the sides.

Contractors are now at work in all the tunnels. Following the trimming operations required to enlarge the excavated sections, they will complete the bores with drill carriages or jumbos which will permit them to mass a number of drills at each face. As a part of the preliminary engineering work done by the commission, the rocks to be penetrated were completely cored throughout the tunnel lengths and the information was made available to the contractors. These borings, consisting of horizontal, vertical, and inclined holes, totaled 15,207 feet. All the rocks are of the sedimentary type, with sandstones largely predominating. Only one area was located which seemed to promise troublesome excavating. In Kittatinny Tunnel was encountered a zone of sand 200 feet wide and under great hydrostatic pressure. A special contract for $75,000 was therefore awarded to cover that particular section.

So far as possible, the line was laid out to traverse the southern and western slopes of the mountains, where maximum sunshine prevails. This will reduce the hazard of snow and ice in winter months. The highest point reached will be 2,442 feet above sea level at Laurel Hill Tunnel, the westernmost of the seven bores. The combined saving in vertical climb attributable to the tunnels will be 4,228 feet. Accordingly, high points on the turnpike will be appreciably lower than those on existing routes, and this will markedly lessen the fog hazard which now materially slows up traffic during certain periods of the year.

The reasons for constructing the turnpike with such great speed are not only to make it available for use as soon as possible but also to reduce the interest that will have to be paid on the bonds before the enterprise starts showing returns on the investment. May 1, 1940, was the date originally set for the completion of all pavement; but on July 12 of this year the time was extended to June 29, 1940. This 60-day extension was granted to obviate the necessity of laying concrete on the roadway during the winter months, when alternate freezing and thawing adversely affect the quality of the finished work.

Experience of the Pennsylvania Department of Highways shows that in most years concrete road slabs cannot be satisfactorily poured in the mountainous regions between November 15 and early spring. It is now planned to lay about 50 miles of the pavement this year and the remaining 110 miles next spring and summer. This re-

vised program will provide a longer time interval for the settlement of fill sections before paving them and will, consequently, lessen the possibility of subsidence after the turnpike is completed. Reports from Germany, where hundreds of miles of high-speed roads comparable to this one have been constructed, indicate that considerable difficulty has been experienced with sagging because insufficient time was allowed for the settlement of such sections before laying concrete.

In the case of the Pennsylvania Turnpike, fills are being placed in a manner that will tend to minimize settling. Specifications require that the material shall be placed in layers, and that each layer shall be thoroughly rolled before continuing upbuilding. The thickness of the layers ranges from 4 to 24 inches, depending upon the materials. The latter figure applies where the fill is composed largely of rock, with dirt filling the voids. Slopes of fills will be 1½ horizontal to 1 vertical. The sides of cuts will normally be 1 to 1. Those more than 50 feet deep in soft material will be benched or terraced and will have drainage ditches at the various levels to carry off water and to prevent washing the material on to the roadway. Cuts in rock will not be benched.

Enough has already been stated to indicate that the building of a highway such as the one specified through a mountainous region at top speed calls for experienced contractors, well-organized staffs, and the most efficient mechanical equipment that can be obtained. It is not surprising, therefore, that the job has attracted contractors from many parts of the United States, that some of the best construction superintendents are directing operations for them, and that the array of powerful rock-breaking and dirt-moving equipment being massed in the attack is the greatest ever assembled on a single highway operation in this country. Fred S. Poorman, assistant chief engineer for the Pennsylvania Turnpike Commission, estimates that the establishment of grade and the building of drainage structures will require the following major equipment or its equivalent: 262 shovels—233 of 2-, 27 of ¾-, and two of 1-cubic-yard capacity, and 192 concrete mixers.

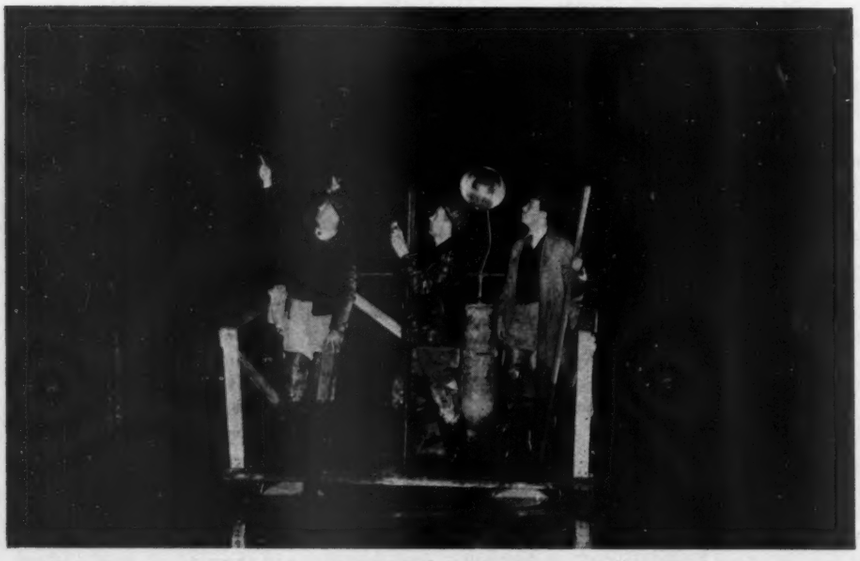
"This," says Mr. Poorman, "represents major equipment, and does not include trucks, batching plants, bulldozers, blade graders, rollers, and similar equipment. We will require approximately 6 rollers for every 5 shovels, and from 3 to 10 trucks or tractor wagons for each 2-yd. shovel, depending on the length of haul. Probably one bulldozer or blade grader will be used for each roller employed."

This tabulation does not include air compressors nor rock-drilling equipment, and does not take into consideration equipment that will be needed to drive the tunnels. In most sections, grading contracts involve the removal of much rock, and contractors are generally using portable air compressors and wagon drills, although many hand-held drills are also being utilized. Each tunnel operation will call for the services of from 12 to 25 drifter drills, and it is a safe prediction that several hundred rock drills will be on the job by September 1.

The commission estimates that the turnpike has already given employment to half the available qualified men in the communities contiguous to the route; and when operations reach their peak, thousands more will be on the payrolls. The contractors handle all labor in accordance with Federal regulations, and preference is given to persons on relief, provided they are capable of doing the work. Wages run from 52½ cents an hour for unskilled labor to $1.40 for highly skilled workmen, with the average around 75 cents.

It will be readily apparent that the preliminary engineering data and designs necessary to put the work underway had to be prepared very quickly. In some instances, engineering staffs have worked without regard to fixed hours, and even now they are following rigid schedules. Samuel W. Marshall, formerly chief engineer of the Pennsylvania Department of Highways, is serving as chief engineer for the Turnpike Commission and has brought with him many of the men who worked under him. The staff now includes qualified experts in all the lines of engineering that the project entails. The personnel working under the commission in all capacities now numbers more than 1,100; and offices that have been established for them have filled virtually all the available space in the downtown section of Harrisburg adjacent to the State Capitol. To facilitate supervision of construction and to expedite the work, the route has been divided into a number of small sections. The operations in each section are divided into one or more contracts. Field engineering offices have been established at Mount Pleasant, Somerset, Everett, and Shippensburg. The PWA is represented by James F. Murphy as project engineer, and by others; Col. F. E. Lamphere, as inspecting engineer, heads the RFC representatives; and Thomas C. Frame is serving as chief engineer for the Pennsylvania Department of Highways.

Following is a list of the contracts awarded up to August 5, with essential details of the work they cover:



INSPECTING AN OLD TUNNEL

Prior to the letting of contracts for driving the tunnels, engineers and geologists made a detailed examination of the excavated sections of the bores that were undertaken more than 50 years ago. The unexcavated portions were core-drilled to ascertain the character of the rock the drillers would be likely to encounter there. All but one of the nine tunnels incorporated in the old South Penn Railroad line were found to be in generally good condition. Six of them are being used, while an entirely new bore is being substituted for the Allegheny Tunnel and open cuts will replace two others near the western end of the route. The picture shows Dr. A. B. Cleaves, chief geologist (left), Joseph Gorman, assistant geologist (center), and another member of the staff utilizing a raft to inspect the timbering in one of the old bores.

Grading and Drainage Structures

L. M. Hutchison, Mount Union, Pa., 9.54 miles in Cumberland County, $458,058.80; also 5.54 miles in Fulton and Huntingdon counties, $429,781.78

Girard Construction Company, Inc., Philadelphia, Pa., 9.56 miles in Bedford County, $444,758.98

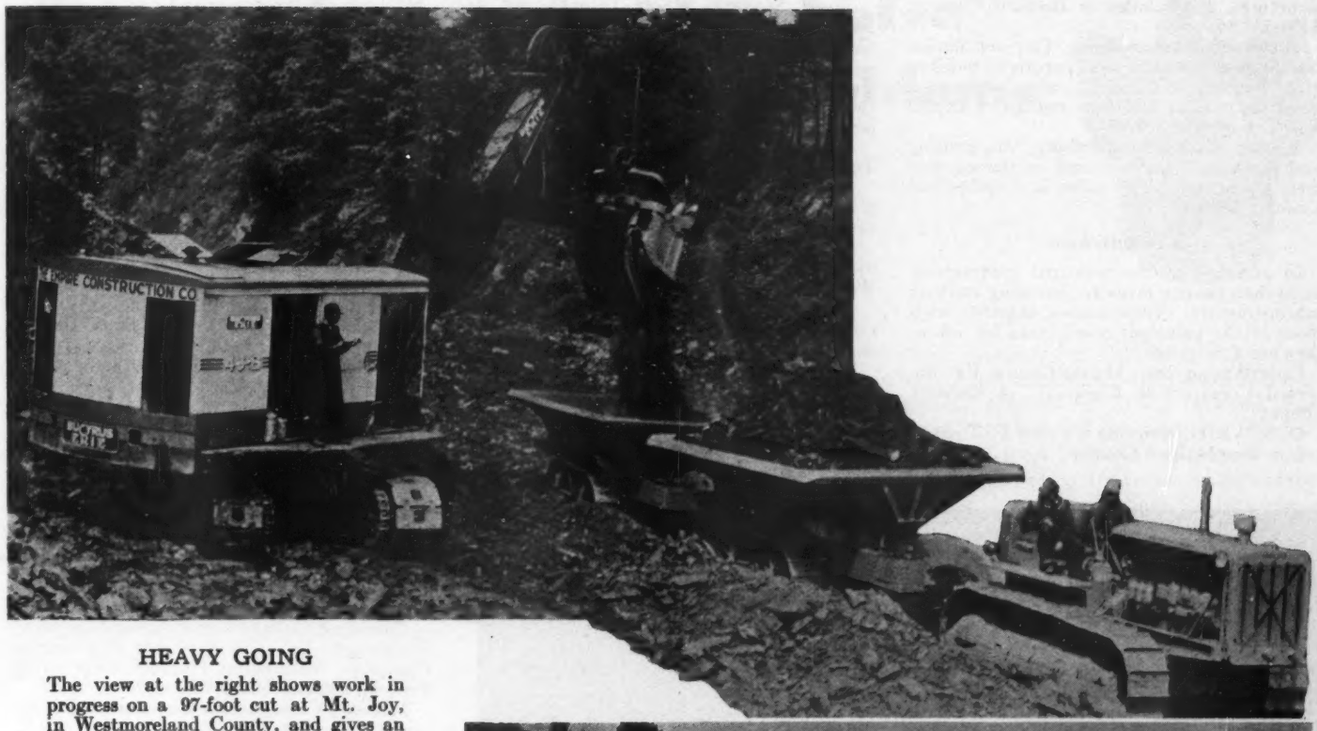
C. T. Burket, Vineland, N. J., 0.69 mile in Cumberland County, $115,627.24

M. Edward Wilt & Sons, Millersburg, Pa., 0.247 mile in Cumberland County, $29,884.52

C. J. Langenfelder & Son, Rosedale, Md., 6.91 miles in Fulton County, $418,813.89; also 9.54 miles in Franklin County, $731,466.88

Guthrie-Marsch-Peterson Company, Chicago, Ill., 1.78 miles in Westmoreland County, $505,091.54; also 6.52 miles in Westmoreland County, $709,957.49

Nello L. Teer, Durham, N. C., 2.924 miles in Fulton County, $132,495.06; also 3.38



HEAVY GOING

The view at the right shows work in progress on a 97-foot cut at Mt. Joy, in Westmoreland County, and gives an idea of the huge gashes that are being made through the hills at various points along the line. The sturdy, large-capacity dirt-moving equipment pictured above is typical of the type that is being employed on the job. The scene of operations is Bedford County.

miles in Bedford County, $795,244.27

Empire Construction Company, Baltimore, Md., 5.452 miles in Bedford County, $773,-918.32

County Construction Company, Carnegie, Pa., 7.55 miles in Somerset County, $663,-164.64

McCrady Construction Company, Pittsburgh, Pa., 2.88 miles in Westmoreland County, $354,072.13

Connell & Laub Construction Company, Dayton, Ohio, 3.05 miles in Somerset County, $240,532.48; also 2.75 miles in Somerset County, $624,295.94; also 6.70 miles in Somerset County, $605,113.59

Frank Mashuda, Milwaukee, Wis., 4.10 miles in Westmoreland County, $582,711.21

York Engineering Company, York, Pa., 2.47 miles in Bedford County, $315,406.36

N. R. Corbisello, Binghamton, N. Y., 0.96 mile in Bedford County, $882,710.48

Ferguson & Edmondson Company, Pittsburgh, Pa., 4.33 miles in Westmoreland County, $489,540.55

Adam Eidemiller, Greensburg, Pa., 5.29 miles in Westmoreland County, $699,588.14

George Vang, Inc., Pittsburgh, Pa., 5.52 miles in Westmoreland County, $616,596.24

N. B. Putman Company, Harrisburg, Pa., 0.113 mile in Bedford County, $164,955.98

H. R. Dickens, Philadelphia, Pa., 0.28 mile in Somerset County, $138,466.87

Dalton Bros. Inc., Paoli, Pa., 1.96 miles in Fulton County, $234,593.00

H. W. Shaull & Son, Mechanicsburg, Pa., 4.92 miles in Franklin and Cumberland counties, $287,833.77

Baldwin Bros. Paving Company, Cleveland, Ohio, 1.38 miles in Westmoreland County, $415,736.70

Central Pennsylvania Quarry Stripping & Construction Company, Hazleton, Pa., 7.27 miles in Somerset and Bedford counties, $1,561,920.63

Herman Holmes, Crystal Falls, Mich., 7.13 miles in Bedford County, $1,513,504.98

Holt-McConnell & Osborn, Cannonsburg, Pa., 0.335 mile in Fulton County, $52,222.74

Johnson, Drake & Piper, Inc., Freeport, N. Y., 5.38 miles in Cumberland County, $1,213,588.88

Tunnels

Arundel Corporation, Baltimore, Md., Sideling Hill Tunnel and two approaches, 2.526 miles in Fulton County, $2,444,527.25

Hunkin Conkey Construction Company, Cleveland, Ohio, Laurel Hill Tunnel and two approaches, 2.39 miles in Westmoreland and Somerset counties, $1,920,281.48

Guthrie-Marsch-Peterson Company, Chicago, Allegheny Tunnel and two approaches, 1.86 miles in Somerset County, $2,672,188.40

Bates & Rogers, Chicago, Ill., Kittatinny and Blue Mountain tunnels and approaches, 2.348 miles in Franklin County, $2,920,123.00

Mason & Hanger Company, New York, N. Y., Rays Hill Tunnel and two approaches, 1.33 miles in Bedford and Fulton counties, $1,549,718.50

B. Perini & Sons, Inc., Framingham, Mass., Tuscarora Tunnel and two approaches, 2.05 miles in Huntingdon and Franklin counties, $2,055,939.67

Miscellaneous

B. F. Sturtevant, Boston, Mass., fans, motors, and transmission equipment for all tunnel ventilation buildings, $217,330 plus operating cost of $96,360.00

York Engineering Company, York, Pa., 0.77 mile of viaduct and grading and drainage structures in Bedford County, $326,209.62

Hen Johnston, Inc., West Reading, Pa., 172 unlighted signs and 7 lighted signs, covering all contracts, $5,336.78

Ferguson & Edmondson Company, Pittsburgh, Pa., New Stanton Viaduct and grading and drainage structures, 0.36 mile in Westmoreland County, $364,864.81

M. Bennett & Sons, Indiana, Pa., Dunning Creek Viaduct and grading and drainage

structures, 1.293 miles in Bedford County, $496,532.36

Ritter Bros., Harrisburg, Pa., ventilation buildings at east and west portals of Sideling Hill Tunnel, $191,270.71; also ventilation buildings at east and west portals of Laurel Hill Tunnel, $95,548.05

Walker Bros., Chambersburg, Pa., grading and drainage structures and reinforced-concrete pavement, 10.28 miles in Cumberland County, $886,027.28

Subcontracts

In addition to the principal contractors, more than twenty firms are handling work as subcontractors. Their names, together with those of the principal contractors for whom they are acting, are:

Penn Wayne, Inc., Manns Choice, Pa., for Girard Construction Company, in Bedford County

D. S. Warfel, Newville, Pa., for C. T. Burket, in Cumberland County

D. M. Stoltzfus & Son, Talmage, Pa., for M. Edward Wilt & Sons, in Cumberland County

H. E. Ramsey and Pittsburgh Fly-Rite Company, both of Pittsburgh, Pa., for Guthrie-Marsch-Peterson Company, in Westmoreland County

H. F. Blough, Johnstown, Pa., for Nello L. Teer, in Fulton County

John F. Keeler, Green Lane, Pa., and Reed & Kuhn, Elysburg, Pa., for Empire Construction Company in Bedford County

G. A. & T. M. Wagman, Dallastown, Pa., for McCrady Construction Company, in Westmoreland County

Hinman Brothers, Denver, Colo., for Hunkin Conkey Construction Company, in Westmoreland and Somerset counties

Howes & Farrell, Inc., Sidney Center, N. Y., for Connell & Laub Construction Company, in Somerset County

A. R. Coffeen, Decorah, Iowa, and Fayette Roofing Company, Uniontown, Pa., for Frank Mashuda, in Westmoreland County

Samons-Robertson Company & Boxley Brothers, Inc., Huntington, W. Va.; H. O. Brechbiel & Son, Orange, Va.; and Asheville Contracting Company, Chambersburg, Pa., for Bates & Rogers, in Franklin County

Phoenix Bridge Company, Phoenixville, Pa., for York Engineering Company, in Bedford County

George Vang, Inc., Pittsburgh, Pa.; Everett Lumber Company, Everett, Pa.; and W. V. Panghorne & Company, Philadelphia, Pa., for Mason & Hanger Company, in Bedford and Fulton counties

Carnegie Lumber Company, Pittsburgh, Pa., and W. V. Panghorne & Company, Philadelphia, Pa., for B. Perini & Sons, Inc., in Huntingdon and Franklin counties

Bethlehem Steel Company, Bethlehem, Pa., for C. J. Langenfelder & Son, in Franklin County

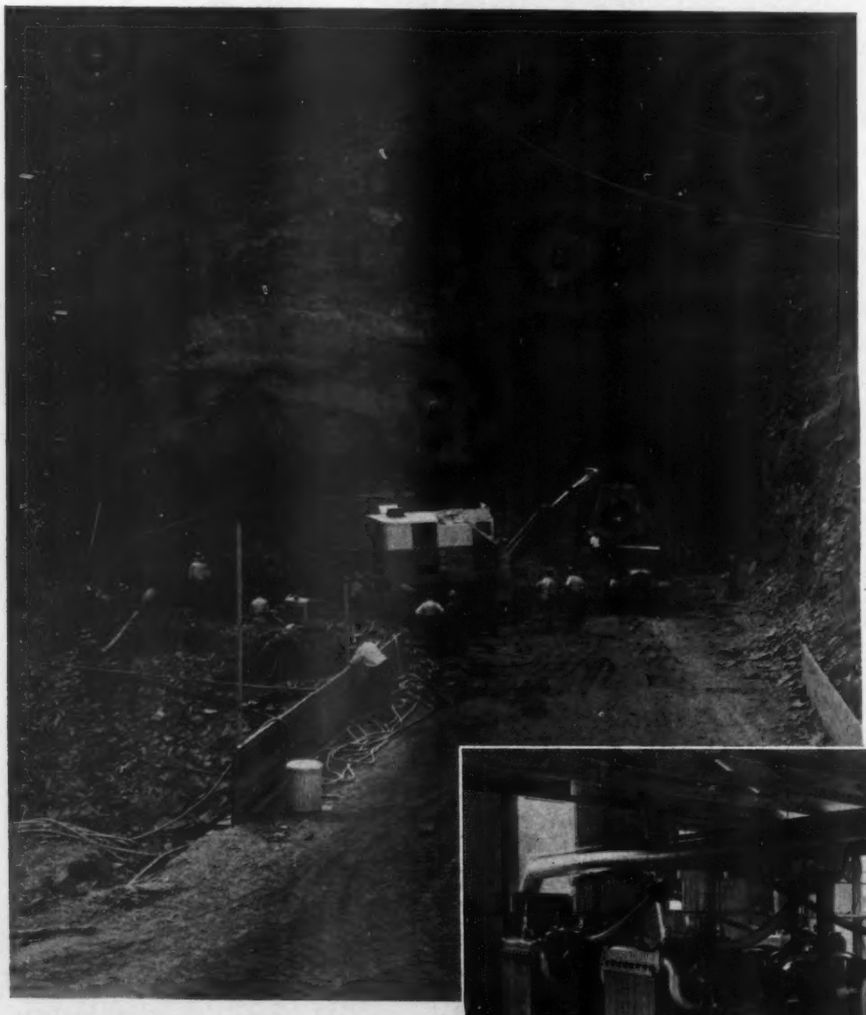
Dodd Construction Company, Spencer, W. Va.; Marshall Company, Dover, Ohio; Zambano & Sons, Greensburg, Pa.; and Conte Eastwood, Pittsburgh, Pa., for Ferguson & Edmondson Company, in Westmoreland County

Eau Claire Engineering Company, Eau Claire, Wis., and Ralph W. Fimple, Fairmount, W. Va., for Adam Eidemiller, in Westmoreland County

Carrodo & Galiardi Construction Company, Pittsburgh, Pa., and Tri-State Engineering Company, Washington, Pa., for George Vang, Inc., in Westmoreland County

Mignetti Construction Company and Raymond Concrete Pile Company for H. R. Dickens, in Somerset County

Reed & Kuhn and Bethlehem Steel Company for Dalton Brothers, Inc., in Fulton County



TUNNEL PORTAL, AIR PLANT

The east portal of Kittatinny Tunnel, showing the cleaning up of the approach preparatory to starting the work of enlarging and completing the bore. This and the adjacent Blue Mountain Tunnel will be driven by Bates & Rogers of Chicago. At the right is the plant that has been set up to supply some of the compressed air that will be required. There are six Type 40 compressors arranged in three pairs. Each pair is driven by one centrally disposed motor through dual couplings.

Special Jackbits Solve Unusual Drilling Problems

STANDARD BITS

From left to right are shown the Carr, the 4-point, and the 6-point type of Jackbits. Collectively, these three styles are satisfactory for probably 95 per cent of the world's rock-drilling work, and special bits are recommended only when unusual conditions prevail.

THE rapid growth in the use of detachable bits for rock drilling has been mentioned in these pages from time to time. Their increasing demand has come about primarily because they save from 10 to 40 per cent of the cost of drilling. The amount of the saving naturally depends upon the application, and, in general, is greatest in mines for the reason that in them the drilling places are ordinarily considerable distances from the surface and the item of transportation is a costly one for conventional drill steel and a comparatively inexpensive one for detachable bits and drill rods.

Detachable bits have many advantages over conventional sharpener-forged steel, and these have been mentioned so many times that they are familiar to almost everyone interested in them. We are referring to their more obvious points of superiority, most of which were apparent at the time or soon after detachable bits were introduced. However, it has been only a few years since they made their appearance; and as wider experience with them is gained, additional advantages are being discovered. Perhaps discovered is not the correct word, for in reality the advantages are the direct result of advances in the art of making bits on the part of the manufacturer, and the advances, in turn, are the outcome of cumulative knowledge of the performances of detachable bits and of extensive research both in the manufacturing plant and in the field.

When machine drills first began to supplant manual drilling, much attention was given to the shape of the bit. Previously, hand drillers had used only the chisel-type bit which presented only one cutting edge. In an effort to increase the speed of drilling, bits were designed with multiple cutting edges. They were of many forms, some simple and some complex. Experience proved that most of them were not very effective; and, after a period of experimentation, the industry standardized on a few shapes. The most satisfactory of these were the 4-point bit with two cutting edges crossing each other at right angles, the 6-point bit with three intersecting cutting edges spaced 60° apart, and the Carr bit, which was an adaptation of the simple chisel bit. Of these, the 4-point bit became the most popular, and probably 90 per cent or more of the world's rock drilling has been done with it.

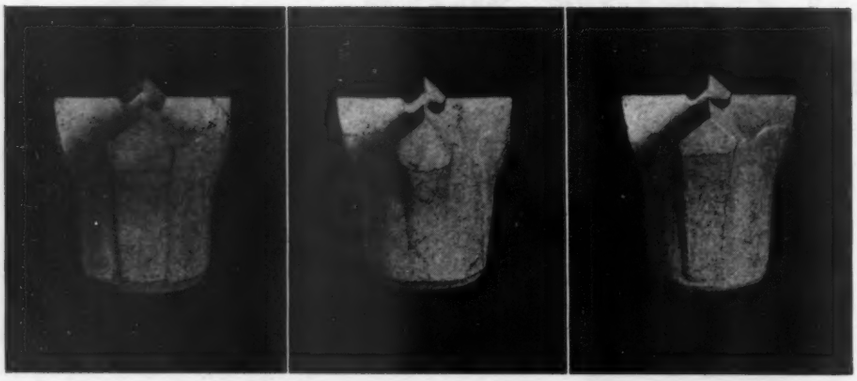
When detachable bits were developed, it was only natural that they should follow accepted forms and, as a consequence, 4-point, 6-point, and Carr bits of this type were made available. By reason of facts already established, it was believed that among these would be found the bit that would be most suitable for general rock-drilling purposes. However, in the course of their efforts to introduce the bits, manufacturers here and there encountered special conditions under which standard bits were not entirely satisfactory. In an attempt to provide something better, they began to modify standard bits in one particular or another, depending upon the character of the rock and other factors that had a bearing on the problem in hand.

As a result, there have come into being special bits, each one designed to drill a particular kind of ground. Ingersoll-Rand Company, manufacturer of a line of detachable bits sold under the trade name of Jackbits, now offers a considerable number of these special-purpose bits. In every case they have been made to meet a set of conditions prevailing in a certain locality; but it is found as time goes on that they are also well adapted for use in other sections where similar conditions are encountered. Although there is a possibility that this development may lead to a general-purpose bit that is better than the types now available, that eventuality is at present not foreseen. Existing standard bits are still the most suitable type for a large percentage of all drilling jobs, and special forms are recommended only when experience proves that they are needed.

In almost every case, special bits are the result of collaboration between the engineers of the company employing them and

"A" BITS

These special bits, which are made in a number of sizes in both the 4-point and the 6-point styles, are characterized by raised cutting edges and deep recesses between the wings. They do not clog readily, there is little tendency of the drill hole to rifle, and they are easy to remove from the hole. They can be reground faster than standard bits.



THREE MINING BITS

From left to right, these bits are known as the Iron, the California, and the Montana. They are generally similar in design, all of them having buttresses to give additional body strength. They are used principally in certain mining areas where special drilling problems are encountered.

the engineers of the bit manufacturer. In some instances, they are the result of a manufacturer's effort to duplicate in a detachable bit a special sharpener-made bit developed by the user to meet some unusual drilling condition on his property. The facility with which this can be done is remarkable; and as every Jackbit turned out under factory conditions is identical with every other one of its type and size, the user is given a uniform product that is not subject to the variations which are unavoidable when bits are forged on solid steels in the field.

One interesting example of such a duplication is the case of a mine in Mexico that did not consider it worth while to give Jackbits a trial because they have a round center hole and its practice was to make up bits on conventional steel with a square hole. That shape of opening was preferred because the rock being drilled contained many round pebbles which sometimes plugged the center hole. With a square opening there was still room between the pebble and the corners for the passage of air or water, whereas with a round hole the opening was often completely closed. Upon learning of this circumstance, the manufacturer made some Jackbits with a square pilot hole. They were tried, found effective, and adopted for regular use. Later, a way was found to make standard round-hole bits perform satisfactorily in this mine—a change that led to a saving in money because of the difference in cost in favor of the latter.

There is one important distinction between the special bits of today and the numerous types that were tried and discarded as ineffective during the first years of mechanical drilling. The difference lies in the fact that the new bits were developed by changing certain features of standard bits and not by revolutionary departures from proved forms. In other words, the special bits are all still 4-point and 6-point bits—mostly the former: they are standard bits that have been modified in one or more dimensions.

One broad general class of these special detachable bits is known as the A Bit. It is the standard 4-point or 6-point bit with raised cutting edges and deep spaces between the wings. This type is often found to be superior to standard bits in soft rock, or in hard, friable rock. The deepness of the passages between the wings serves to prevent their clogging. As a result, air or water can pass through them readily, and the bits are consequently good hole cleaners. With them there is also little tendency of the hole to rifle, and they are generally easy to remove from the drill hole. They can be readily reground, and are so shaped that the gauge surface does not become excessively long after repeated regrinding. They are strong and resist breakage well, and can be rehardened without difficulty. An A Bit can be reground about 25 per cent faster than a standard bit, which means that more bits can be reground with one grinding wheel.

Separate and distinct from the line of A bits are seven special bits that are named after specific localities or kinds of rock in which they find their greatest application. All are of the 4-point type. Of these, the Montana, California, and Iron bits can be grouped, as they are similar. All are of the buttress type—that is, the wings extend down the sides in raised sections.

Engineers of one of the large copper-mining companies and of Ingersoll-Rand Company collaborated in the development of the Montana Bit. It is intended expressly for drilling in the Butte copper mines, and is used there well-nigh exclusively. The diameter of the body is smaller than it is in standard bits, providing maximum space for the passage of cuttings back out of the hole. The buttresses, however, give the required strength. This also makes it easier to remove the bit from the hole. It comes in sizes of 1⅝ to 2⅛ inches, inclusive, and has a gauge angle of 3°, which is the same as that of the most-used standard bits.

The chief difference between the California and Montana bits is that the former has a heavier skirt that is the equal in strength of that of standard Type 1 bits. This refers to the thickness of the wall in the body of the bit, or to that part that screws on to the drill rod. This gives the bit increased resistance to fatigue failure and fits it for use in medium-hard drilling rock. It is ⅛ inch longer than standard bits, and is made only in 2- and 2⅛-inch sizes. The gauge angle is 3°. The California

JASPER BIT

This is the strongest Jackbit made. It was designed for drilling the extremely hard jasper found on the Vermillion Iron Range in Minnesota, but is now also used elsewhere. It has very wide wings and 105-degree-angle cutting edges to give it high resistance to battering of the edges and corners.

Bit was developed for a group of gold and copper mines in that state and in Idaho.

The Iron Bit, which was designed for use in a Minnesota iron mine, is intended for still heavier service than the California Bit. The thickness of the skirt is the same as it is in standard bits, but added strength is given it by the buttresses. It is suitable for drilling in hard rock where hole-cleaning power and minimum gauge and corner loss are important. As it also resists rifling, which is often experienced in soft rock, it is applicable for use in the few localities where both hard rock and rifling rock must be drilled with one type of bit. It is made only in 2-, 2⅛-, and 2¼-inch sizes. It has a double-taper gauge, the angle being 0 degrees to a point 5/16 inch from the ends of the cutting edges and 7½° for the remaining distance. It has a wing width of ¾ inch, which is greater than that of either the Montana or the California Bit.

The Jasper Bit is the bull of all Jackbits, being made extra strong for drilling the very hardest rock. It was developed primarily for one of the leading mines on the Vermillion Iron Range in Minnesota, but now is also used in a mine in Michigan. As mentioned in an article in our October, 1938, issue, the average penetration per bit in the jasper of the Soudan Mine near Tower, Minn., is less than 2 inches, it being generally conceded that it is the hardest rock that is regularly drilled in any commercial operation. This particular bit has wide wings—⅞ inch—and 105° angle cutting edges to give it maximum resistance

to the battering of edges and corners. It is made only in 2- and 2⅛-inch sizes. Its gauge angle is 3°. It is intended for but one purpose, that of drilling extremely hard rock.

The Barre Bit was designed to reduce the cost of quarrying granite in the Barre, Vt., area, and is now also used by some of the Minnesota granite producers. It has long been the practice at Barre to drill a line of closely spaced vertical holes and to break down the wall between adjacent ones with a broaching steel. These holes are drilled as much as 18 feet deep; and under the former system of reducing the size of the bit each time steels were changed, the holes became progressively smaller as they went down and the rock left between adjacent ones proportionately thicker, adding to that extent to the broaching time and expense. The problem was solved by

BARRE BIT

This bit will drill an 18-foot hole in granite with little or no loss in diameter and is, accordingly, used for drilling and broaching in some of the quarries of Vermont and Minnesota. It is a very strong bit, and is deep-hardened to provide as many as eight regrindings. It is ordinarily used with 4-inch drifter drills.

devising a bit that loses very little gauge and that can, consequently, be followed by another of the same size. These bits will drill an 18-foot hole that decreases little, if at all, in diameter from top to bottom. As this results in intervening rock sections of substantially uniform thickness, the broaching operation is simplified and shortened.

The Barre Bit is extra strong and is deep-hardened. It can be reground as many as eight times, or used nine times, without rehardening. The first regrinding removes approximately 1/16 inch of metal from the gauge, and each subsequent redressing operation results in a reduction of only about 0.025 inch. The wings of the bit are 1 inch wide, and the gauge angle is 0 degrees for ⅜ inch and 7½° for the remaining distance. The Barre Bit is made in 2½- and 2¾-inch sizes. It is ordinarily used with 4-inch drifter drills.

A special bit known as the Picher Bit, that serves approximately 100 lead and zinc mines in the Tri-State Mining District, was described in our February, 1937, issue. It was developed to drill the chert and flint that had long presented a vexing problem there because of their extreme abrasiveness and the occurrence in them of cavities of various sizes. The rock is very brittle and breaks in such a manner that a dull bit is almost as effective as a sharp one. Accordingly, it is now the practice to use each of these special bits without resharpening until its wing diameter has been worn down to that of the body, after which it is discarded. An average of 18 feet of hole is drilled with one bit, and in the more free-drilling rock as much as 60 feet has been obtained.

The Picher Bit has an outside wing width of ⅞ inch. Owing to its raised cutting edges, it drills fast and cleans the hole well. The outstanding characteristics of this type are parallel gauge wear and nonrifling. It has been applied successfully to medium-hard rock where minimum gauge wear is desired, as well as to limestone, marble, concrete, and other materials where rifling is to be avoided. It is made in 2⅞-, 2½-, and 2⅝-inch sizes.

The final member of the list of special bits is the so-called Copper Bit. It was designed to drill the amygdaloidal copper ore of the Lake Superior Mining District in which considerable native copper occurs. It is a small bit and is made only in the 1⅝-inch size. It is deep-hardened, and as there is little reduction in gauge when using

PICHER BIT

More than 100 mines in the Tri-State Mining District use this bit for drilling the chert and flint that are associated with its lead and zinc ores. It has been used successfully in medium-hard rock where minimum gauge wear is desired and in marble and other materials where rifling is to be avoided.

it in this rock, virtually all the grinding is done on the face in order to renew the cutting edges. As a result, it can be reground as many as eight times.

This bit is the only one that has both a center and a side hole. In addition, it is distinctive in that the center hole is not countersunk, so there is no tendency for it to act as a funnel for the ductile native copper. Nevertheless, when native copper is encountered, the center hole is very often plugged, and in that case the side hole still serves to feed air or water to the bottom of the hole to remove the cuttings and thus to prevent the steel from sticking.

From what has been written and from an examination of the accompanying pictures, it will be realized that all the special bits are formed by exaggerating or by suppressing some feature of a standard bit, or by adding a new characteristic. It has been found that most of these bits, although each was originally developed with some specific location in mind, are superior to any other bit in other areas or when employed for drilling rocks for which they were not designed. As a result, their use is being extended. An example of this is the adaptation of the Picher bit for drilling marble, which is a soft rock, while the chert and flint of the Picher area are hard.

Because they possess definite advantages, it is very likely that some of the special bits will become standard. At least, much is being learned by modifying standard bits; and it is certain that the fund of information that is being amassed will lead to continual improvement in all types of bits. For the present, however, existing standard bits answer the requirements of ordinary rock-drilling jobs.

As the manufacture of special bits calls for additional equipment and involves extra operations, their production cost exceeds that of standard bits and, consequently, they command a higher price. Obviously, they must show better results to warrant their purchase. From the user's standpoint, their employment is justified when more or less exceptional drilling conditions are encountered, for they make it possible to perform successfully and profitably drilling operations that could not be carried out satisfactorily with standard types of detachable bits.

COPPER BIT

This is a small bit that was designed especially for drilling the Lake Superior amygdaloidal copper ores in which considerable native copper occurs. It has both a side hole and a center hole, the former serving to pass water or air to the bottom of the hole when the center opening becomes clogged. It is made only in the 1⅝-inch size.

Five Compressors Used on 63 Large Jobs

"NUMBER 21"

The original Type XL compressor purchased by the George J. Atwell Foundation Corporation in 1931 and carried on its records as No. 21. It is shown on its first job (right)—the excavating of the foundation for the World-Telegram Building on West Street in downtown New York. The housing was erected over the unit to protect it from the showers of mud, stone, and miscellaneous materials which were experienced every time one of the hollow steel piles was blown with air after being driven through the soft ground that was formerly the shore line of the Hudson River.

AT THE NETHERLANDS BUILDING

The five machines lined up along the street curb on their most recent job—that of supplying air for excavating the foundation of the Netherlands Building in Radio City. This structure, which will soon be ready for occupancy, is rising in the space between the Time and Life Building and the Center Theater, and extends from 48th to 49th Street.

THE START OF RADIO CITY

The skyline of midtown Manhattan looks considerably different now than it did when this picture was taken. The 70-story RCA Building, largest office structure in the world, occupies the site behind the fence. The George J. Atwell Foundation Corporation started excavating for it on July 23, 1931. The two wheeled houses in the center each contain a Type XRB stationary compressor, belt driven from an electric motor. At the left is a later unit of the same type and also electrically driven but with a simpler mounting that made it more compact and easier to move about. Up the street, right, are the two original gasoline-engine-driven Type XL units. The compressor end is similar to that of the earlier models.

TO THE "sidewalk superintendents" of New York and to others who take an interest in excavation jobs in the nation's largest city, the sight of green-and-white mechanical equipment in and near a gaping hole in the ground is a more or less familiar one. To their experienced eyes that color scheme stamps the equipment as the property of the George J. Atwell Foundation Corporation, for on every piece of any size will be found the company's trademark—a white area of diamond shape with the word "Atwell" painted on it in distinctive green letters. As its name implies, the concern specializes in excavation work, and over a span of twenty years it has been present at the birth of many of New York's largest structures.

Wherever an Atwell foundation job is in progress, from one to five portable compressors will be found—usually along the street curb, with air lines leading from them to the rock drills that bite away at the distinctive New York rock, which is called Manhattan schist. These portables have a creditable service record. They are not of the more commonly used type, but a larger model with two horizontally arranged compression cylinders protruding from one end and with the driver, power transmission gears, and cooling system inside the housing. Each machine delivers 425 cubic feet of air per minute at 100 pounds discharge pressure. The particular units were made by Ingersoll-Rand Company and are designated the Model XL.

Among Atwell's five XL units is the first one of that type ever built. It is a gasoline-engine-driven machine and was purchased in February, 1931. It went to work 24 hours a day for four months on its initial job—the excavation for the World-Telegram Building in downtown New York. The site was on filled ground along the former shore line of the Hudson River, and was found to be underlain by old piers and a miscellaneous aggregation of material that had been dumped there. Hollow steel piles, later to be filled with concrete, had to be driven to a firm bearing, and the XL supplied the air both for driving the cylinders and for blowing them free of water, mud, and debris. In designing the foundations, consideration was given to the fact that they were to support large newspaper presses and that they would, accordingly, have to possess the utmost stability. Despite the conditions encountered, this was obtained, and the presses are still in perfect alignment.

On the Atwell records, the original XL compressor is listed as No. 21. Two months after it was put to work it was joined by No. 22, a duplicate. No. 22 was initiated into service on the foundation for the Metropolitan Life Insurance Building where it operated twenty hours a day for three months. That was a rock job. In 1936, the company bought three more units. These were of the same model as the two others except that they were driven by Type H oil engines instead of gasoline engines.

Collectively, the five compressors under discussion have worked on 63 separate jobs, all in New York City. On nine of them they ran either sixteen or twenty-four hours a day. Included among the excavation operations were the foundations for various buildings in Radio City, several Frederick F. French buildings, the new Federal Court House, the new Federal Post Office, and numerous other big structures. Other large-scale undertakings were the depression of the New York Central tracks on the west side of Manhattan Island to eliminate grade crossings, and the sinking of foundations for a part of the West Side Elevated Highway.

In Radio City, where the Atwell Company has done probably 80 per cent of the foundation work, the compressors have been used on seven operations involving the removal of close to 1,000,000 cubic yards of rock. The largest of these was the 70-story RCA Building, where the general level of the basement is 60 feet below the curb line and the extreme depth is 90 feet. The average depth of the six other excavations was 38 feet below the curb. The most recent job completed in this major construction enterprise of the Rockefeller family was the foundation for the Netherlands Building, which was "topped out" a few weeks ago.

The repair bill for the five XL's has been remarkably low. Aside from replacing a few valves, cleaning the valves regularly, and occasionally repacking the stuffing boxes of the piston rods, nothing has been done to any of the compression cylinders. The gasoline engines in the two original units have undergone one cylinder reboring, but otherwise have required little else. New cylinder liners have been placed in the Type H oil engines of the three newer machines, but there again the cost of repairs stops. The transmission gearing shows practically no wear; and all the compressors still have all their original bearings. Since the units went into service they have lost no time because of the need of repairs: any work of this kind that they required has been done week-ends when the jobs on which they were employed were closed down.

Bonneville Fishways Improve on Nature

Robert G. Skerrett

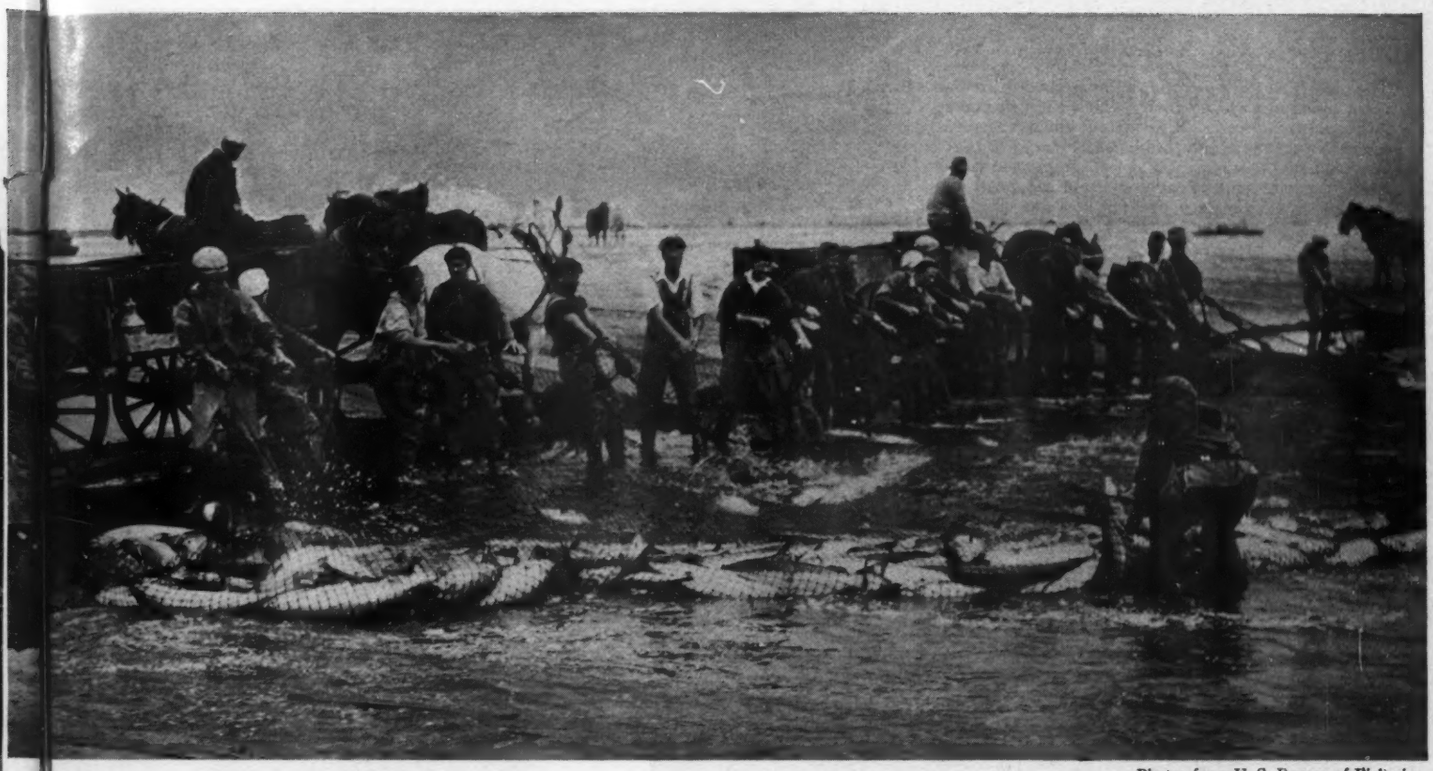
THE fishways of the Bonneville Dam are an unqualified success! More than that, they have made that dam on the Columbia unique among the impounding river structures built to date by the United States Government. Constructed at a cost of $6,553,000, they assure the continuance of the salmon industry on that stream—a commercial activity that has a value to the economic life of the nation in excess of $15,000,000. Its annual income, which affects the gainful occupations of more than 21,000 workers, is around $10,000,000.

The salmon of the Columbia River have supplied the native Indians for centuries with one of their prime foodstuffs. Ever since the first white men settled in those parts of Oregon and Washington through which that stream flows, the catching and preparing of salmon for the market has been an industry of steadily increasing economic importance. From available records, covering nearly three quarters of a century, we learn that in 1866 the combined output of canned and other preserved forms of Columbia salmon amounted to 272,000 pounds. In 1936, production totaled 23,528,578 pounds, while in the single year of 1911 the stream's widespread fisheries provided 49,480,008 pounds of canned, mild-cured, and frozen salmon. To be still more specific, in the twelve years 1924-1935, the commercial fishermen of Washington and Oregon caught 383,938,500 pounds of salmon and steelhead trout, the aggregate value of which was $32,732,630. No wonder that those directly interested and familiar with the habits of Columbia River salmon were fearful that the construction of the Bonneville Dam would either destroy or greatly reduce this self-perpetuating source of wealth.

To appreciate what the Bonneville Dam fishways represent as a solution of a complex problem concerning so many people and diversified interests, it is necessary to have some knowledge about the different kinds of salmon that frequent the Columbia River system and the habits of those creatures. In the course of untold time, the various species have adapted themselves to the seasonal changes of the stream's flow, to swiftly moving waters, and to the cascading reaches that have put to the test the young fish journeying for the first time downstream to the sea and, later, the full-grown salmon working their way upstream to the waters in which they were hatched. To be successful, man-made fishways have to simulate the natural difficulties presented by the river courses to which the fish have become accustomed.

The blueback or sockeye, the chinook or king, the silver, and the chum are the four kinds of salmon found in the Columbia River system. To these should be added the steelhead trout, one of the finest and gamest of our fishes, which also is a migratory creature and of much commercial importance. The blueback is the most valuable; the splendid chinook comes next; then the silver salmon; and the chum is fourth in rating. The blueback may attain a maximum weight of 6 pounds, while the chinook averages 22 pounds at maturity but may reach from 70 to 100 pounds.

Choice as the blueback is, the chinook is by far the most important species identified with the Columbia, and its yearly catch is of much greater weight than that of any of the others. An adult steelhead trout may



Photos from U. S. Bureau of Fisheries

COLUMBIA RIVER GAME FISHES

At the left, on the opposite page, a steelhead trout, bound upstream to spawn, is seen leaping Kettle Falls, a 15-foot water drop 700 miles inland. In the foreground is a basket such as the Indians have used to catch trout and salmon since long before the arrival of the white man. The center picture shows a specimen of adult male blueback salmon in spawning condition. Commercial fishermen are pictured above making a haul of salmon from the Columbia River.

weigh as much as 30 pounds; and every ounce of him is full of fight. The annual take is between 2,000,000 and 4,000,000 pounds—varying from year to year—and ranges in value from $42,000 to $286,000, according to supply and demand. The chinooks, during their sea-going career of several years, may be found along the Pacific Coast all the way from the Ventura River, in California, northward to Norton Sound, Alaska.

All Columbia River salmon are anadromous fishes: they spend the greater part of their lives feeding and fattening in the open ocean, but invariably return to the stream to spawn in fresh water. It is while they are on their homing journey to reproduce their kind that they are intercepted by fishermen both offshore and within the Columbia River system. The chum, the silver, and some of the fall chinooks usually spawn in its lower tributaries; but most of the spring chinooks and bluebacks ascend the river for several hundred miles to breed in those inland waters where each was hatched years previously. On their run to the spawning areas the adult fish do not eat: they live entirely on the fat stored in their bodies while sojourning in the ocean, and that source of energy impels them onward against all accustomed difficulties in response to the homing instinct. If the conditions met are too severe, the fish may become exhausted or so injured that they cannot reach their goal.

The females deposit their eggs in the shallow tributaries and in the gravel of the spawning beds. The eggs hatch in from two to four months. The wee fish do not leave the gravel immediately, but stay there for a while obtaining nourishment from the yolk of the egg that remains attached to each one. When that foodstuff is gone, the small creature, called a fingerling, works its way upward and out of the gravel. Shortly afterwards, some of them begin the long descending swim to the sea; but others remain a year or more in fresh water before beginning that instinctive journey.

The fish grow more or less rapidly during their first six months of fresh-water life, the majority being from 3 to 6 inches long by the time they enter the coastal waters at the mouth of the Columbia. While in the river system, the habits of the young salmon and steelhead trout are much the same. On reaching the Pacific, the salmon fingerlings range far and wide in search of plankton organisms and the small fish upon which they feed—growing fast the while. Depending upon the species, salmon remain in the offshore waters from three to six years before attaining sexual maturity and starting upon the return trip to their spawning areas where they breed and die, if not intercepted by fishermen on the lookout for them.

The habits of the steelhead trout at maturity differ from those of the salmon. After spawning, adult steelheads again seek the sea; and it is known positively that female steelheads may ascend the river five successive seasons to spawn, in the meantime going back to the ocean. In designing the fishways at Bonneville, provision had to be made for the safe downstream passage of full-grown steelheads, whereas only salmon fingerlings make that descent. Young steelheads start seaward when they are from one to three years old—most of them when they are two, and remain in the Pacific for two years before reëntering fresh water to spawn.

Steelheads spawn from February to May. The chinook salmon return to the river system during the months of May, June, and July, although there is a fall run in August and September. Both of these runs, however, spawn about the same time—in the late summer or fall. The Bonneville Dam occupies a strategic position in regard to the migratory habits of the chinook, the blueback, and the silver salmon. This is also true concerning the steelhead trout. According to investigations made by the U. S. Bureau of Fisheries, something like 75 per cent of all the salmon frequenting the Columbia have long been accustomed to pass the dam site during their migratory movements. It was because of this that extensive research preceded the preparation of the final plans for the Bonneville fishways. The utmost care was taken to provide structures that would lure to them the homing fish and make it relatively easy

FISH LADDER

The picture at the right shows the method of creating a series of water steps by which the fish make the upward journey. Rising from the transverse concrete partitions are upright steel channels that serve to hold the timber stoplogs of the surmounting weirs. Near the end of each partition are openings through which the ascending fish can pass if they do not desire to hurdle the weirs. On the opposite page, at the top, is seen a similar fish ladder in service.

Courtesy, the Bonneville Project

WHERE THE FISH ENTER

The homing fish avoid the violently disturbed water issuing from the spillway gates and head toward the less vigorous currents at the left that lead to one of the water ladders. The fish, however, will not enter the portal of a fishway unless the outpouring water is considerably agitated. To produce this turbulence, the flow at each entrance is increased to ten or fifteen times that of the fishway with which it is connected. This is accomplished by discharging water into the entrance from underground conduits.

Photo, U. S. Army Air

for them to get by the barrier with the least practicable demand upon the stored energy that has to carry them to their destined spawning waters. It is not generally known, but there are other fishes of value that go up and down the river at the Bonneville Dam.

Years ago, Atlantic shad were transplanted to the waters of the Pacific Coast. They have thrived in the meanwhile and are now found in considerable numbers in the Columbia. The commercially important sturgeon also inhabits the river; and some have been observed traveling through the Bonneville fishways. An eel-shaped creature, classed as a "lamprey" but unlike the Atlantic eel, has a life history and habits much akin to those of the salmon. During 1938 as many as 200,000 lampreys passed through the counting gates at the dam, and it is believed that they will be found of value as food. Finally, suckers, squawfish, chubs, carp, etc., have used the fishways in following their migratory courses. All of which proves how essential those structures are—a fact that will no doubt be emphasized as years go on.

Where the Bonneville Dam now stands, the Columbia formerly flowed through two channels separated by Bradford Island. The main channel is now occupied by the spillway section of the dam; and the lesser channel is blocked by the power house and the navigation lock. The structures arrest the normal flow of the stream sufficiently to create a pool extending upstream for 46 miles to a point beyond The Dalles. The level of this pool is 66 feet above the surface of the river immediately downstream of the dam when the Columbia is at a very low stage; but when it is at freshet stage, and the excess water is pouring past and over the spillway, the difference in level may be not more than 30 feet. The backwater of the long pool is not a quiescent body, despite the arresting action of the dam. Because of the large volume of the river's flow, and the narrow but precipitous gorge through which it moves seaward, it is characterized by pronounced currents at all stages. The perpetuation of this condition is intimately connected with the habits of the homing fish, which seek opposing currents in following the trackless routes that lead them back to the waters in which they were hatched.

The Bonneville Dam fishways were designed by members of the Corps of Engineers, U. S. Army, in collaboration with experts of the states of Oregon and Washington and of the U. S. Bureau of Fisheries. In some important respects those technicists had to blaze their own trail. Up to that time there had not been built, either in America or Europe, a structure of the size of the Bonneville Dam that would obstruct migratory fish runs of the magnitude of those at that site. The conditions to be satisfied there were on an unprecedented scale. Furthermore, the solution of the problem was made more difficult because it was assumed that a large percentage of the descending fingerlings would pass through the turbines.

The adopted power wheels are somewhat like a ship's propeller, have a maximum diameter of 23 feet 4 inches, and the blades are adjustable so as to assure operating efficiency at different stages of the river. The wheels turn at the relatively slow rate of 75 rpm., and the descending water, in moving them, follows passages which have

TAKING THE CENSUS

As the fish reach the top of one of the waterways (below), they are counted and classified as to species. These records not only prove whether or not the fishways are effective but, over a course of years, also will give valuable information as to whether the supply of certain varieties of fish is diminishing.

Courtesy, the Bonneville Project

BONNEVILLE DAM

The power house and ship lock are at the right and the spillway at the left, with Bradford Island in the center. Fishways are visible in the center and at the extreme left.

minimum openings of from 1 to 3 feet. Laboratory studies indicated that only a small proportion of the fingerlings would suffer injury in dodging the revolving wheels and in tracing a serpentine course from the pool to the river at the downstream side of the barrier. However, the turbine passages are but one of six ways by which the young fish can make their run past the dam. They can use the skimmer gates that extend the full length of the power house upstream, or descend by means of the Bradford Island fish ladder, the Tanner Creek fish ladder, the special by-passes—one at each end of the dam, or go through the navigation lock when that is in operation. Indeed, most of the fingerlings will in all probability use passages other than those offered by the turbines.

The fishways are of two kinds—pool-type fish ladders and fish locks; and to make them more effective, the Army engineers added an unusual feature which is known as a "collecting" system. This is located at the entrance of each fishway and serves to attract and to lead the fish to the latter. The lure of the collecting system hinges upon the magnitude of its entrance and upon the volume and velocity of the water issuing from it. Therefore it is expanded either horizontally or vertically or in both directions, and is much larger than the true fishway entrance. Beneath the floor of this advance portal is a series of diffusing chambers through which an auxiliary supply of water is discharged from a conduit system that makes it possible to control both the volume and the velocity of the issuing water. By this means the normal flow of a fishway is augmented from ten to fifteenfold and the discharge at the entrance of the collecting system is raised to 2,000 or 3,000 cubic feet per second—equivalent to that of a sizable river.

When completed, the Bonneville Dam was equipped with three sets of fishways placed at each end of the spillway and across the face of the power house. Each is made up of a collecting system, a fish ladder, and a pair of fish locks. The ladder and the locks connected with a given collecting system may be operated simultaneously or separately. The fish locks at the two ends of the spillway form integral parts of that structure, and each consists of a vertical, hydraulic shaft or chamber 20x30 feet in cross section and built of concrete. At the bottom of this shaft is a gate-controlled opening, 10 feet square, that communicates with the water on the downstream side of the dam, and near the top is a similar opening that faces upstream and communicates with the water of the pool. A conduit system, which has its openings in the bottom of the chamber, makes it possible either to fill or to drain the fish lock.

When upbound fish are to be lifted from the lower to the upper level at the dam, the bottom gate of the lock is opened and water is discharged from the basal conduits and allowed to flow vigorously outward—thus simulating a rapid or a cascade and attracting to the shaft the fish already gathered in the collecting system. Then the bottom gate is closed, and the conduits discharge enough water into the chamber to fill it—the fish rising at the same time. When the level of the water in the shaft and that of the pool are the same, the top gate is opened and the fish are free to escape and to continue their upstream migration. A submerged grid, that slopes toward the exit gate, may be slowly raised beneath the fish to cause them to flee from the chamber. With the fish gone, the top gate is closed, the lift chamber is drained, and all is in readiness for opening the bottom gate to begin another transfer. The locks are used only to handle such of the migrants as are too lazy or otherwise indisposed to surmount the dam by swimming up the

From Corps of Engineers, U. S. Army

MAP OF BONNEVILLE DAM, SHOWING LAYOUT OF FISHWAYS

There are three sets of fishways, one across the face of the power house and one at each end of the spillway, made up, respectively, of a collecting system, a fish ladder, and a pair of fish locks. By actual count, made only during the hours of daylight when fish do most of their swimming, a total of 1,074,662 fish—including 362,711 salmon, 106,453 steelhead trout, and 605,492 other species—passed upstream through the fishways in a period of six months, proving that Bonneville Dam is no barrier to the fish of the Columbia River System.

fishways. The locks are in pairs so that one shaft will always be open to receive fish while the other one is discharging its passengers into the pool upstream of the dam.

The fish ladders are concrete ramps with perpendicular flanking walls of the same material. Each of these passageways curves around an end of the dam, forming a connecting waterway between the pool and the river just below. It has an internal width of 40 feet, and every 16 feet there is a bottom partition, 6 feet high, which is surmounted by an extension or weir formed of wooden stoplogs. These transverse barriers create a succession of pools or watersteps with 1-foot rises over which the descending water cascades—to that extent reproducing the tumbling broken water through which the migratory fish used to pass a short way above the dam site in going up and downstream. At the bottom and at one side of each partition are two submerged openings, each 2 feet square; and the fish are free to use these portals or to jump the hurdles or steps in going from the river below the dam to the pool above it, a distance of about 1,200 feet. The volume of water flowing down a ladder may be controlled at the upstream end so as to create conditions that will be more likely to cause the fish to swim than to jump from pool to pool. This, of course, is to save the reserve power of the fish so that they will have ample energy to carry them to their destinations.

The wisdom of the foregoing effort to help the fish along their way will be better understood when it is realized that chinook salmon and steelhead trout follow the Columbia River system even into British Columbia in order to spawn. Last fall, when the fishways were put to their initial test, only a few of the fish climbing the ladders ever rose above the surface of the water while doing so, although thousands and thousands of them made use of those routes. As a consequence, salmon taken from the river about 50 miles upstream of the dam were found to have much firmer flesh than ordinarily because they had not spent their substance and strength in reaching that stage of their long homing journey.

An additional fish ladder is under construction and will link Tanner Creek, downstream of the dam, with Bradford Slough, the lesser river channel now blocked by the power house and ship lock. It is intended primarily for downstream migrants, but will be available for fish bound upstream. This passage is made up of a number of comparatively short, typical ladder sections placed between a series of long pools, and the expectations are that it will attract a large percentage of the fingerlings making their way to the sea. And now let us see how it has been possible to determine the effectiveness of the fishways and so establish the wisdom of the money spent upon them.

Fish-counting stations have been provided at each ladder. A station consists of a picketed barrier having three gate-controlled openings, each 2 feet wide, for the passage of fish—a submerged white platform over which they have to swim as they issue from the counting gate facilitating enumeration and identification of the different species. As fish swim but little at night, the counting has been done during daylight hours; and at the peak of the run last fall, from two to three of the stations at each ladder were in operation. The actual count thus made for a period of six months showed the upbound migrants to be as follows: 271,361 chinook, 74,961 blueback, 15,150 silver, and 1,245 chum salmon. There were also checked 106,453 steelhead trout, 2,067 other game fish, 5,325 shad, 2,241 whitefish, 223,248 lampreys, and 372,611 scrap fish—that is, suckers, squawfish, chubs, carp, etc. There was never any evidence of fish accumulating below the dam: they slipped from pool to pool of the ladders or up through the locks with ease; and the commercial catches of salmon at points well above the barrier indicated that the fish were arriving at their accustomed rates.

Mr. J. D. Ross, administrator of the Bonneville Project, has reported that state officers and river fishermen agree that the fishways will perhaps be the means of saving the famous royal chinook salmon from extinction. The counting stations can be expected to let fisheries' experts know with reasonable accuracy how many salmon are returning during a run to the headwaters to spawn; and by being thus forewarned it will be practicable to reduce the permissible catch, should conditions warrant, to guard against dangerous depletion.

The homing trend of salmon and steelhead trout may be altered by handling "ripening" fish, kept for the purpose in holding ponds, so as to induce or hasten spawning artificially. The eggs so obtained and fertilized can then be planted in suitable waters and left there to hatch. The young fish will journey from those sources to the sea and, on arriving at sexual maturity, will leave the ocean and seek the newly established areas for spawning. This course may be followed to effect the redistribution of fish that have heretofore traveled to those parts of the Columbia River system that lie above the site of the Grand Coulee Dam if fishways at that dam should be found impracticable or too costly to build and operate.

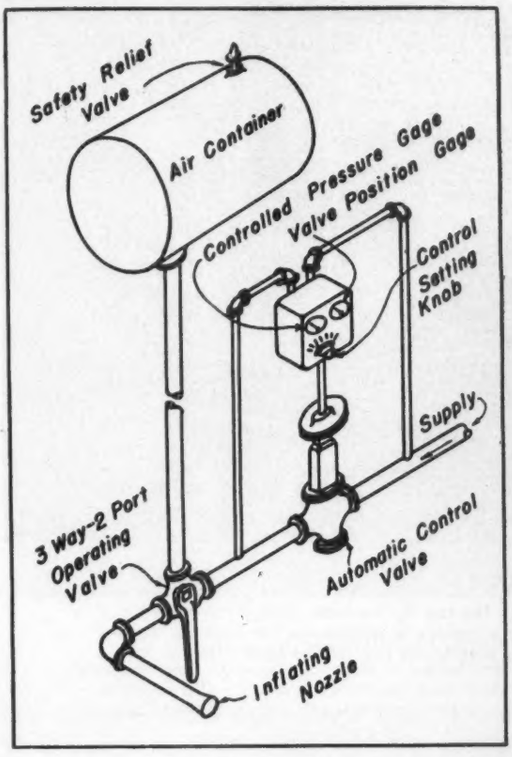
The Bonneville Dam fishways have necessarily been a big experiment, and were provided to serve the fisheries industry of a single river. But what has already been learned there and what may still be discovered bid fair to prove of the greatest value in dealing with kindred problems involving some of our other inland waters. Thus, we may amplify and widen our sources of foodstuffs and to just that extent contribute to the natural wealth of the nation and to the common good.

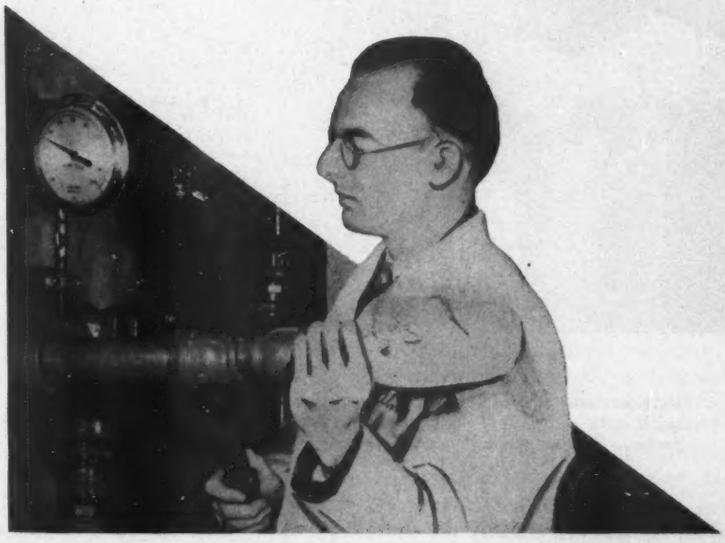
The author wishes to acknowledge his indebtedness to Maj. Theron D. Weaver, Corps of Engineers, District Engineer at Bonneville, Oreg., for much valuable information.

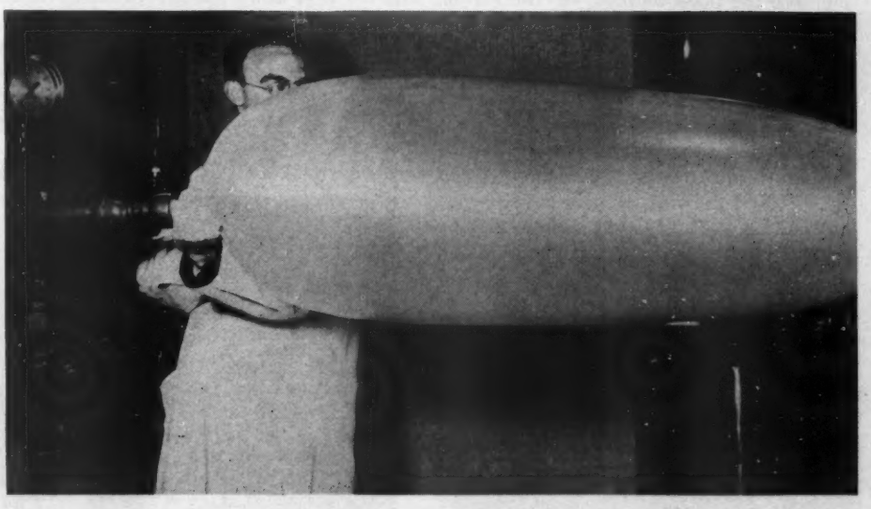
Since this article was written, J. D. Ross has died and has been succeeded as Administrator of the Bonneville Project by Frank A. Banks.

Compressed Air and Vacuum Help the Meat Packer

A. M. Hoffmann







BLOWS 'EM UP

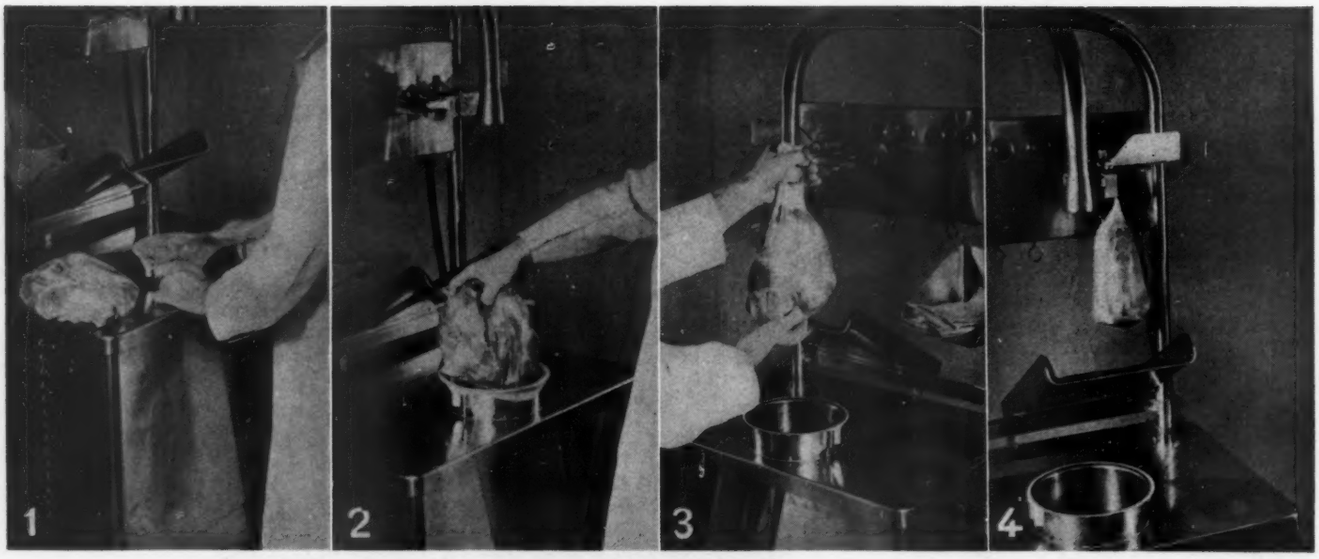
At the top, left, is shown the general arrangement of the air-supply system for the inflation of the large-size rubber-latex bags. They are slipped, one at a time, over the inflation nozzle, top right, and charged until they are fully distended, bottom right. Experience has proved that the equipment can handle 500 sacks an hour, and that they can be applied, vacuumized, and sealed at the rate of 150 to 250 an hour, depending on the weight of the cuts, the method used, and the skill of the operator.

RUBBER, because of its peculiar properties, has so many applications that to list them would become wearisome. However, among the newest uses is one that is of vital concern to every household because it has to do with the packaging of meat products for freezing and storage or subsequent processing. It is now the common practice to protect such foodstuffs by glazing them or by wrapping them in one, two, or three layers of waxed paper or other waterproof film with or without stockinette, which serves as an added safeguard. While adequate as a covering, they do not offer a sufficient seal to keep out air and to prevent dehydration. Contact with oxygen, as is well known, causes fat to become rancid, while loss of moisture affects the flavor and texture of meat.

In search of a material that would not possess these shortcomings and that would at the same time meet the requirements of a wide range of irregular-shaped foodstuffs, the Dewey & Almy Chemical Company, Cambridge, Mass., turned to latex of a particular kind, and has produced a bag that will readily conform to the contours of poultry, hams, large and small cuts, and even carcasses. In addition, the company has developed machinery and equipment to facilitate packing. The sacks are made of specially compounded and highly purified rubber latex, and, besides being vapor and moistureproof, are said to be odorless and to impart no taste to the food. They also remain pliable, and even though they can be pierced, they will not become brittle and split.

The Cry-O-Vac Process, as it is known, involves distending the bags, filling, vacuumizing, and closing them. Inflation is effected either with measured amounts of compressed air or by the so-called vacuum-can method, depending upon the product. Sacks for large sides of meat are expanded by holding each over a nozzle connected by piping to an air receiver. The latter contains just enough air to distend the bag to the desired extent, the initial pressure of the air serving as a gauge. The room in which this work is done is chilled, as is also the room or container in which the bags are stored until ready for use. Unless exposed to temperatures of 50°F. or higher, they do not shrink appreciably, and remain tissuelike, transparent, tough, and resilient.

The vacuum-can method of inflation is suitable for poultry or standardized small cuts weighing not more than 15 pounds. In this case, each sack is drawn down into an open-end receptacle by suction. When the bag has been satisfactorily distended, the meat is put in, and the air is removed by inducing a positive vacuum. Sealing concludes the operations, all of which are performed by a self-contained machine.



THE VACUUM-CAN METHOD

Here is shown the self-contained bench by means of which small cuts of meat of fairly uniform size can be quickly packed. The sequence of operations is as follows: 1, drawing a bag down into the can by vacuum applied externally; 2 filling the sack; 3, pulling a vacuum on the package to exhaust the air; 4, sealing the bag by the application of heat.

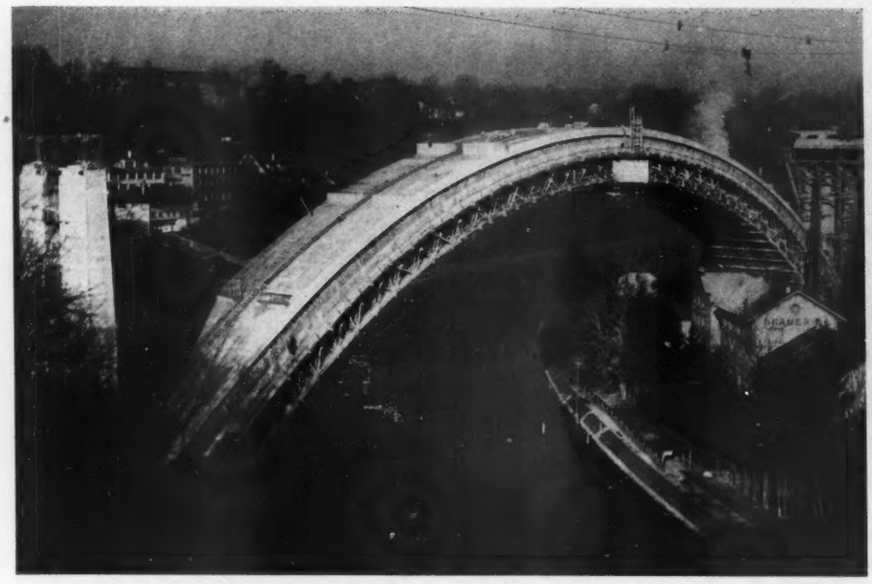
Filling of the sacks expanded with compressed air is done variously by the chute method, the hook method, or the slip-on method. By the first, each bag is pulled over the lower end of a small stainless-steel chute, and a ham or the like is pushed down into it. By the second, the mouth of the sack is gripped by two metal hooks attached to a bench, thus permitting the packer to pull it wide open and to drop the product into it. If it is desired that both of the worker's hands be free, the bag is held altogether by hooks mounted on arms operated by a foot pedal. The slip-on method is used for carcasses—cuts that are too heavy for the men to handle. Each is suspended from a hook, and the latex container is pulled up over it. In any case, the sacks are later evacuated and sealed.

The air is exhausted from the packed bags in two ways, depending on the contents. If the product has smooth, convex surfaces, the entrapped air is removed by the application of either hot air or water at a temperature of 120° and 110°F., respectively. This treatment results in a film that is skintight and lustrous. But if appreciable areas of the cut are concave, it is preferable to pull a vacuum on the bag so as to draw it closely against the irregular faces. With that done, the mouth is twisted shut and sealed by means of heat, a wire tie, or a wooden clothespin. The latter is used if the container is to be returned for repacking, as untorn sacks may be shrunk, washed, and dried. However, the most satisfactory method is to fuse the twisted end by holding it momentarily between electrically heated jaws. Cuts for long-distance shipment, which may encounter rough handling, are given an added Kraft paper or other covering to protect them from abrasion during transit.

Experience has shown that meats packed in Cry-O-Vac bags can be frozen by any of the usual processes, and that the containers do not slow down the rate of refrigeration. Furthermore, it is claimed that they can be quickly frozen either by blasts of cold air which would normally cause what is known as "freezer burn"—severe dehydration—or by submersion in or spraying with liquids which would ordinarily contaminate them. Sharp or quick freezing is of advantage in that the crystals formed during the critical zone from 31° to 24°F. are much smaller than they otherwise would be, thus preventing destruction of the firm texture of the meat by piercing of the cell walls.

BAGGING

Depending on the cuts of meat, the inflated bags are filled by the chute method shown in the insert, by the slip-on method, bottom left, or by the hook method, bottom right.



NEARING COMPLETION

The reinforced-concrete span with its underlying wooden arch that made it possible to dispense with intermediate supports so that the bridge could be built without interrupting shipping and the normal operations of industrial establishments on both flanks of the river. Approximately 52,974 cubic feet of lumber and more than 44,000 pounds of nails, screws, and pegs were required to construct the scaffold. When this picture was taken the structure was about ready to receive the deck.

Arch Bridge Built on Clear-Span Scaffold

RAILROADS converging from Zuerich, Basel, and Biel on Bern, the capital of Switzerland, will soon be able to speed across a fine new reinforced-concrete viaduct and bridge over the Aar River, which borders all but the western side of the latter city. The crossing is the major part of a reconstruction program that was started by the Swiss Federal Railways about two years ago and that also involves the building of a 4-track main-line section to relieve the congestion created at Bern by a bottleneck through which all traffic to and from the aforementioned points must now pass. At present the trains use a 2-track line that is carried across the Aar Valley over a combination trestle and bridge that has long outlived its usefulness.

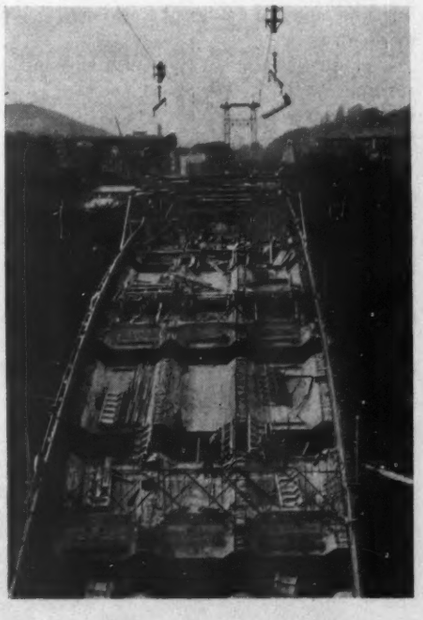
Since the latter structure was erected in 1859, railroad traffic has increased greatly, and the weight of rolling stock has reached such proportions that it is no longer safe to permit two trains to cross it simultaneously. North- and southbound trains have to go over single file; and just what this means can be better appreciated when it is known that 260 trains enter and leave Bern daily by way of that crossing during the summer season when traffic is heaviest. The one now under construction will have four tracks and will be strong enough to bear the aggregate load of as many trains.

From the station at Bern to the terminus of the main-line section, the new elevated structure has a length of 3,587 feet. Beginning at the depot, it is made up of a 542.5-foot viaduct; a bridge, including approaches, 1,968.5 feet long; and a viaduct that traverses the valley for a distance of 1,076 feet. The deck is 57 feet wide and, except for the river crossing, is supported on numerous twin piers that are spaced longitudinally on maximum centers of 91.5 feet.

At the point where the structure spans the Aar, both waterfronts are closely built up; and, after much deliberation, it was decided that a bridge of the arch type would best meet all requirements. The arch has a maximum span of 492 feet, and a clearance at mean high water of approximately 108 feet. It is 46 feet wide, and varies in thickness from a minimum of 10 feet at the crown to a maximum of 16.5 feet at the abutments. To reduce weight without sacrificing strength, it has been divided into three hollow sections. These run lengthwise, and also make it possible to examine the condition of the concrete from within the structure.

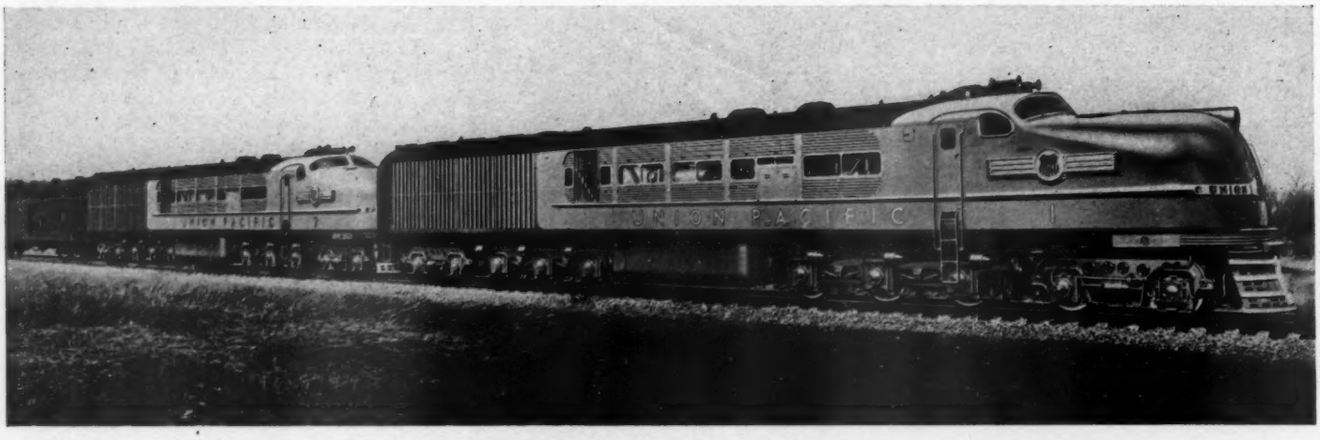
As such bridges go in Switzerland, it is said to be exceptional in size; and because of the congested areas in which it rises, its construction is unusual in some particulars. The outstanding feature of the project is the scaffold on which the arch has taken shape. This phase of the undertaking presented somewhat of a problem because of the lack of space and the fact that work had to proceed without hampering the industrial plants that line both banks of the stream at the building site. River obstructions were prohibited for the same reason. The difficulties were surmounted by first erecting an arch-shaped scaffold of wood that would be strong enough without intermediate supports to carry the burden of the concrete arch to be constructed on top of it. It is the first thing of its kind attempted in Switzerland, and has attracted thousands, including many builders and engineers, to the scene of operations.

Before concreting was started in August of 1938, the working base was subjected to all kinds of tests, including a load test of 3,000 tons. Every precaution had to be taken to prevent the setting up of undue strains during the construction of the arch. To this end the superposed weight was at all times equally distributed by pouring identical sections on opposite sides of the crown simultaneously. The three separate lengthwise zones in each section were placed in lifts, the lowermost one having a thickness of 2 feet. As soon as it was in position, it was ingeniously tied to the wooden platform and thus made to help bear the steadily increasing load.



UNDER CONSTRUCTION

Looking down on the arch and showing the three longitudinal sections each of which is built hollow to save weight and to permit periodic inspection of the interior of the span. A total of 5,885 cubic yards of concrete, or 11,000 tons, entered into its construction. This, together with the reinforcing steel and other necessary materials, forms, and equipment, was delivered to the points of use by means of an aerial cableway. All the concrete was compacted with pneumatic vibrators.



New Union Pacific Steam-Electric Locomotive

THE steam-electric locomotive recently built by General Electric for the Union Pacific Railroad is a significant development. In fact, an electric train carrying its own steam power plant is extraordinary. Its amazing features, however, cannot be grasped until one has a knowledge of the many simultaneous functions which culminate in the faultless operation of each of the two 2,500-hp. mobile power plants that generate the electricity by which the new locomotive is driven. Oil, air, and water are literally made to jump through their respective hoops in producing the energy which sends a train of twelve Pullman cars hurtling along its tracks at speeds up to 100 miles an hour.

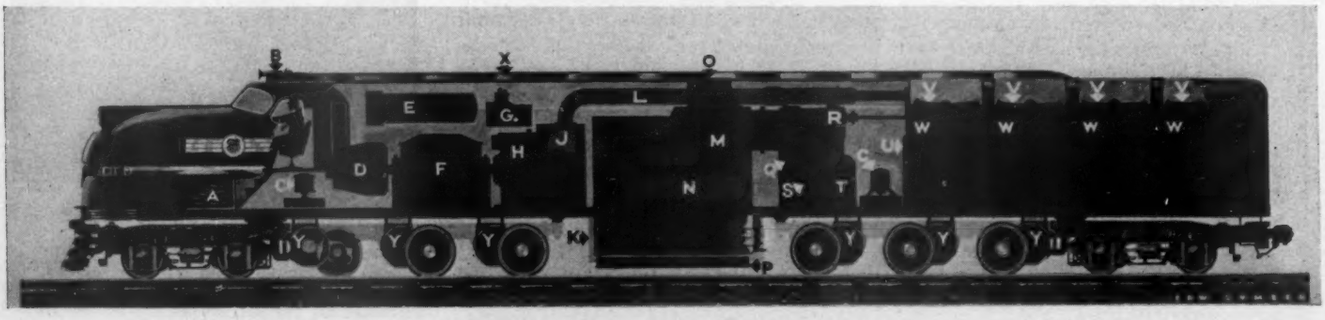
The steam boiler in each unit supplies a turbine with 1,500-pound steam, and boasts nearly all the features of its larger fellows in central power stations. Fuel oil, water, and combustion air flow to it in correct proportions under changing service conditions. The fuel and water pumps and the I-R blower which provides the combustion air are integral parts of an auxiliary turbine set the speed of which varies with the steam demand. In addition to an oil furnace, the steam plant includes a water separator, a superheater that heats the steam to 920°F., an economizer to utilize waste heat in the stack, and an air preheater.

Steam from the boiler drives a turbine set containing both high- and low-pressure units which turn the main traction generator at 1,200 rpm. through a 10 to 1 reduction gear. The generator is self-ventilated by a fan located between two armatures. Steam taken from the main turbine is used to drive the auxiliary turbine previously mentioned. The generator delivers power to six driving motors mounted on separate driving axles. With the traction blowers cooling each motor with 2,000 cubic feet of air per minute, the rated tractive effort is 32,000 pounds. For heavy duty, however, the blowers can double their output to make possible a 40,500-pound tractive effort.

Exhaust steam from the turbine passes to condensing units, placed on each side of the rear cab, and is cooled by turbine-driven propeller-type fans. Distilled water is used in a closed system, and leakage air is expelled by a steam-operated vacuum ejector in the condensing equipment. Condensed water is pumped by two I-R Motorpumps first to a tank in the upper cab and then to a feed-water pump, from which it flows to the feed-water heater, economizer, and boiler tubes.

The auxiliary equipment plays a vital part in the over-all operation. A combination electric- and air-braking system is employed, air for the latter being supplied at 125-135 pounds pressure by a 2-stage compressor. A novel resistor to dissipate the electric-braking energy is made of 350 feet of steel tubing through which cooling water is circulated. An alternator producing electric power for the traction blowers, for air conditioning, and for other services is connected with the generator exciter to the main generator shaft. Lubricating oil circulated by a Motorpump is cooled by radiators located with the condenser. The electrical control system features, for the first time, multiple-unit control of two steam locomotives from either cab.

The reward for the two years of development and construction is a locomotive with many superior characteristics. It is capable of rendering improved passenger service, with a capacity for long runs without stops for fuel or water. It climbs difficult grades without a helper, and has an over-all efficiency approximately double that of conventional steam locomotives. It is now in service in the West.



CUTAWAY SECTION OF ONE UNIT

The 5,000-hp. locomotive is made up of two identical 2,500-hp. units, as shown above. The letters designate the principal parts, as follows: A, raw-water tank; B, vertical headlight beam; C, traction-motor blowers; D, air-conditioning alternator; E, train-heating evaporator; F, main generators; G, air-brake compressor; H, reduction gear; J, main turbine; K, main control contactors; L, exhaust header; M, boiler; N, feed-water heater; O, stack; P, braking resistors; Q, boiler draft fan; R, condenser-fan turbine; S, feed-water pump; T, boiler auxiliary-set turbine; U, fuel tanks; V, condenser fans; W, air-cooled condensers; X, dust deflector; Y, traction motors.

PANAMA CANAL'S BIRTHDAY

THE Panama Canal has a birthday this month. August 15 marks the end of 25 years of service for the "big ditch." After a quarter of a century of operation, it remains the largest single construction undertaking ever carried out by this nation, and its strategic importance is even greater today than it was when the waterway was opened. Similarly, its value in speeding the passage of commercial shipping from one side of the Americas to the other has fully come up to the expectations of those persons who made the canal a reality.

The 50-mile canal cost $541,000,000 to build, and required the excavation of 242,000,000 cubic yards of material. Maintenance operations since the waterway was opened in 1914 have involved the movement of additional large quantities of earth and rock. In Gaillard Cut alone, where 103,000,000 cubic yards of material was originally dug out, more than half as much again has been subsequently handled, much of it having been catapulted down the slopes by slides. Dredges and drills are continually at work in this and other sections of the canal. Maintenance and operation have, together, cost approximately $25,000,000, or $1,000,000 for each year of service. If there is added to this sum the nearly $45,000,000 that has been expended for fortifications, Uncle Sam's total investment exceeds $600,000,000.

Against this outlay there are receipts of some $450,000,000. More than 100,000 ships have used this short link between the Atlantic and the Pacific, the banner year having been 1929 when 6,289 vessels paid tolls. Patronage is now increasing, and it is estimated that by 1960 it will reach 8,000 annually. The largest boat that ever passed through the canal was the British battle cruiser *Hood*, which paid a toll of $22,400.

In view of the present unsettled world conditions, much attention is being given by the Government to making the canal secure against attack. To this end the War Department recently allotted $21,234,000 for the building there of a new airplane base and for increasing the military force of 13,000 officers and men.

DIET AND DRIVING

SOME surprising things are being learned about the effect of diet upon the capacity of the human body to function normally. More and more it is being indicated that our bodies are akin to mechanical power plants, and that the kind of fuel that is supplied to them determines to a considerable extent the efficiency that we get out of them. Since the human body functions in a multiplicity of ways, and as the human diet is a very varied one, the study of how different food elements affect our actions becomes highly complex.

It is becoming increasingly apparent, however, that research along this line may produce results of great practical importance. For example, the Bureau of Home Economics has discovered that the amount of Vitamin A consumed probably has a distinct bearing upon safe automobile driving, particularly at night. Experiments have revealed that a person living on a diet deficient in Vitamin A is unable to see well in dim light. This so-called night blindness may be the cause of many automobile accidents, because such a person's eyes do not function normally at dusk or after dark. One decided weakness is the inability quickly to regain normal vision after staring into the bright lights of approaching cars. It is believed, further, that insufficient Vitamin A narrows the field of vision, and that, even in daylight, persons whose diets are deficient in it may not be able clearly to see cars running alongside them or approaching them from the sides at intersections. They are also less likely to see pedestrians walking on the roadside.

The studies that led to these assumptions included controlled feeding of five persons for six months. All the food consumed was weighed to make certain that each one was receiving an ample and constant supply of calories, protein, fat, calcium, iron, phosphorus, and all the known vitamins except Vitamin A, which was kept as low as possible. Common sources of Vitamin A are yellow and leafy green vegetables, egg yolks, whole milk, orange and tomato juice.

OUR FIRST SUPERHIGHWAY

WORK has been put underway on the Pennsylvania Turnpike at a speed that has seldom been exceeded on a large-scale construction job. Such dispatch recalls World War days, when industry of all kinds moved at the fastest pace attainable. In order to accelerate the preparation of plans and engineering data for the turnpike, technical men were drawn from far and wide. The Pennsylvania Department of Highways contributed freely from its staff, and more than 50 men were literally drafted from the large steel companies in Pittsburgh.

In its physical proportions, this first superhighway in the nation is imposing. Unlike most mountain highways, it goes through elevations instead of around them. Its cost is as awe-inspiring as its grade. Proponents of the turnpike believe that it is to become the nucleus of a network of high-speed roads. Opponents are not so optimistic. They favor good roads; but they question the wisdom of going back to the toll system which proved decidedly unpopular and even intolerable to former generations. Whether or not history will repeat itself remains to be seen. The prospectus of the Pennsylvania Turnpike indicates that commercial vehicles will pay the bulk of its cost, because it will make it possible to effect such savings that trucks and buses will find it profitable to use the road. Just how the casual motorist will feel about it cannot be ascertained. The fact that the highway will revert to public ownership as soon as it is paid for will probably foster public sentiment.

Industrial Notes

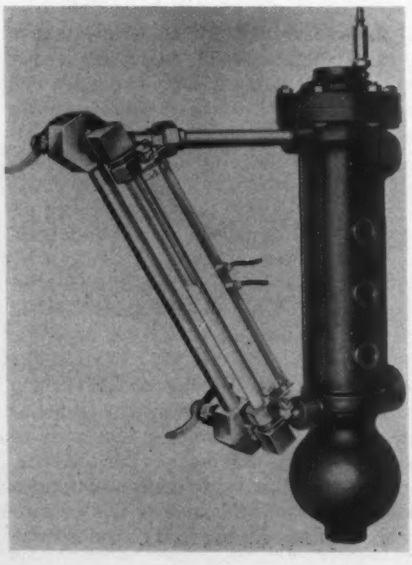
As a precautionary measure, most sizable underground metal mines in the United States use electric cap lamps for lighting. One of the newest of the permissible types available is that of the Portable Lamp & Equipment Company bearing Approval No. 27 of the U. S. Bureau of Mines. It

has a hard-rubber headpiece; a hinged cap hook that permits the wearer to focus the beam on the work he is doing; and a 3-cell, 6-volt battery connected to the headpiece by a rubber-sheathed cable. There are five plates in each cell, and leakage of the acid is prevented by standard gravity-type valves with nonspilling vents. The unit is provided with two filaments to safeguard against light failure. Connection between the molded headpiece and the battery cord is effected by a combination switch and charging plug which controls all functions, including burning of either filament and charging of the battery. When this is done with the aid of Portable Lamp & Equipment Company's "self-service" charging rack or system, each miner can take his lamp off the rack at the beginning of the shift and replace it at the conclusion, thus appreciably cutting down lamp-house labor. The switch end of the cord is simply inserted in a socket on the rack; and when the battery is fully charged the service is automatically discontinued.

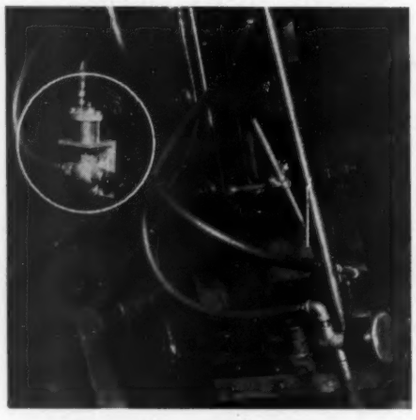
A new light-weight alloy of aluminum and magnesium for shipbuilding was the subject of a paper discussed at a recent London meeting of the Institute of Naval Architects. Navalium, as it has been named, can be produced in plates 1 inch thick and in angles, Z bars, girder sections, and channels up to 85 feet in length. The factor of weight-saving is said to range from 3 to 6 in low-speed battleships and destroyers, respectively. Comparative tests with the alloy and steel revealed that corrosion was five times as rapid in the case of the latter, which also is less resistant to indent damage because of its lower elastic deflection. It is estimated that 1 ton of navalium would make it possible to save 8 tons of steel in structural and machinery weights in the case of battleships, thus more than offsetting its greater cost.

Pilots of airplanes recently have been given another instrument to help them guide their ships safely to their destinations. The device is a product of the Bell Telephone Laboratories, and is known as the terrain clearance indicator. As its name implies, it warns the man at the "stick" how far above the ground he is flying, whereas the older apparatus record only elevation above sea level or some fixed point. The new instrument shoots a radio wave earthward and picks up its electrical echo reflected skyward from the ground. Though sending and receiving are almost instantaneous, the time interval is indicated on a dial in terms of feet, thus giving a direct reading of the exact distance between the plane and whatever happens to lie below it.

Anyone who has squinted up at an ordinary water gauge on a boiler in an effort to make certain of the liquid level, will appreciate the application of Neon illumination, with its penetrating rays, to gauge glasses for either indoor or outdoor service. Wright-Austin Company is offering such an illuminator. It consists of a Neon tube in a dustproof aluminum case and of a magnifying lens which is placed behind the gauge and which, together with the light, extends the full length of the glass. Reading is direct, the water- or liquid-filled part of the glass standing out as a broad red band, while the empty space above is indicated by a hairline red stripe. The manufacturer claims that the actual water level is thus made clearly visible at a distance of 150 feet and more, and that it can be seen distinctly both day and night, as well as through a haze, steam, dust, or fog. Other features of the Neon Illuminator are long life and low operating cost, as it consumes less than 25 watts in actual service. It is furnished complete with a small transformer and an extension cord, can be easily attached by two *U* clamps to almost any standard gauge, and is adaptable for use with either vertical or inclined gauge glasses, as the accompanying illustration shows.



One of the new products recently announced by A. Schrader's Son is a pilot valve that is especially adapted for service in connection with manually fed presses using overhead knockout or compound dies. It is designed to give either a delayed or a prolonged blast of air, as may be desired, for ejecting work from a press after the ram has stopped its upward movement.



The duration of the blast can be regulated by a simple screw adjustment on the valve which, with the vent closed, may be employed on any mechanism as an air valve. The advantages claimed for the new device are that it is easy to service, conserves air, and does away with the need of interchanging machine parts to obtain the results of a timed blast of air.

The State of New Mexico, alone, could supply more energy from solar heat than is now obtained from all the coal, oil, and water consumed annually in the United States in the generation of heat, light, and power, according to C. G. Abbott, an authority on solar radiation. Mr. Abbott has been experimenting with solar-heat appliances for twenty years, and claims that it is now practicable, by reason of present-day aluminum products and vacuum devices, to manufacture water heaters, cookers, and boilers of this type on a wholesale scale.

Continuous Vacuum Filters for the Mining Industry is the title of a 26-page bulletin recently issued by The Eimco Corporation, Salt Lake City, Utah, well-known manufacturer of mining and metallurgical equipment. It is a profusely illustrated publication and, in addition to giving a de-

tailed description of its disk- and drum-type filters—together with associate machinery and parts, shows some typical installations and also devotes a chapter to the *General Principles of Continuous Vacuum Filtration.* Bulletin No. 402 can be obtained from the manufacturer upon request.

Oil-shale coke is being processed with limestone to form what is said to be a high-grade cement possessing unusual resistance to bending and impact.

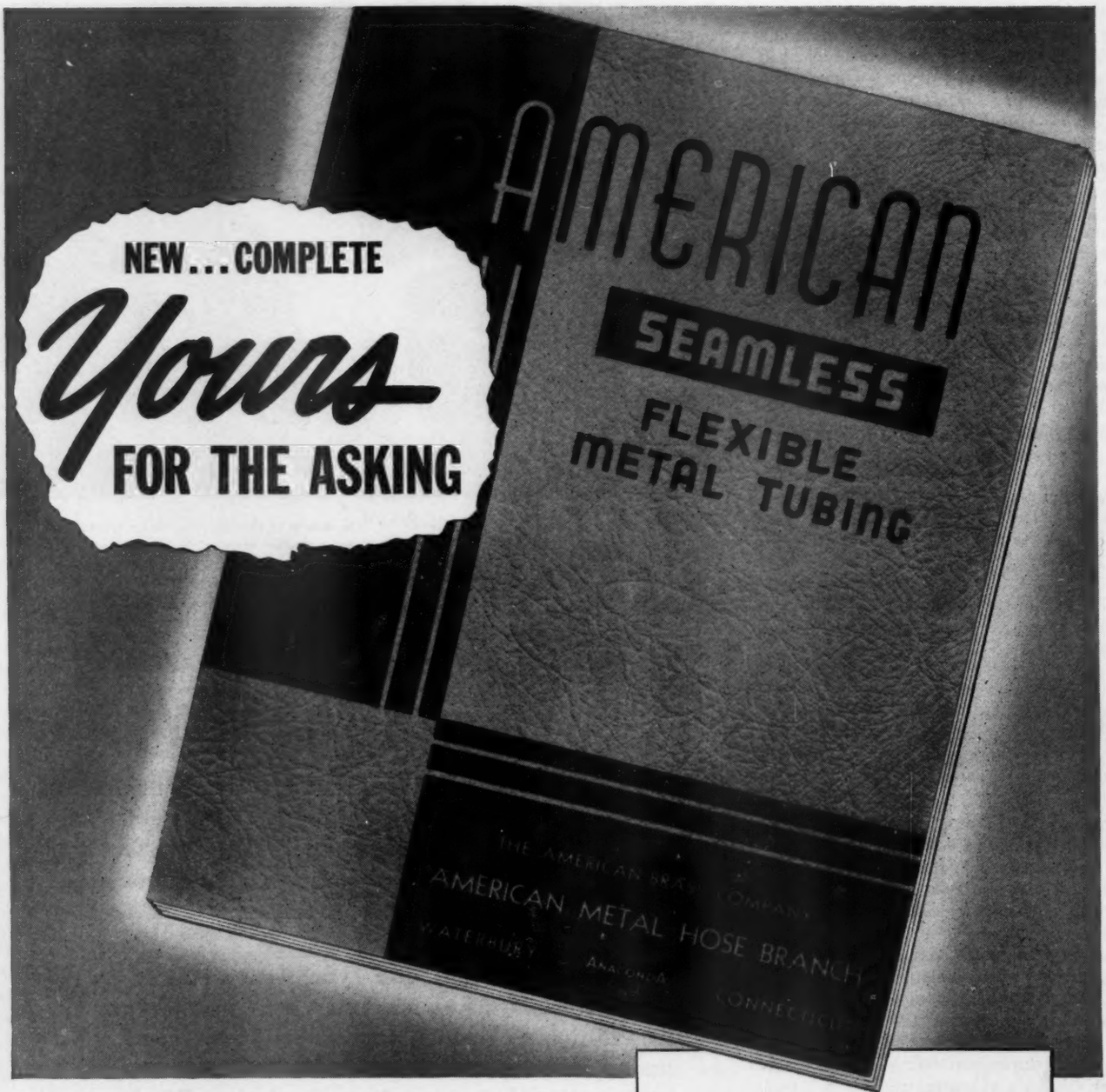
In the cab of the newest electric railways of the Swiss Federal Railways there is a wireless tension indicator that enables the engineer to determine without difficulty whether or not the power-transmission line is energized.

To prevent frequent and costly replacements, London's underground telephone cables are now being coated with sodium silicate before laying. This chemical forms a film that protects them against corrosion caused by the acid subsoil in that region. Test specimens buried for a period of eight years in exceedingly acid soil are said to have remained unaffected.

A process for the hydrogenation of peat has been developed in Finland and is said to give an aggregate yield of benzine, fuel oil, and lubricating oil equal in weight to 48 per cent of the dry material treated. There are extensive peat beds in the country, and these are to be exploited if the tests now being conducted by the government in a large experimental plant built by it prove the process to be commercially practicable.

After years of experimentation and testing, the Bachite Development Corporation is ready to grant licenses for the use of its process of coloring stainless steel. Coating involves spraying the surfaces of the metal locally or throughout with a colorless chemical solution and heating the steel to a temperature that will not distort or otherwise harmfully affect it. On the list of possible colors are red, purple, green, blue, black, and bronze.

Armor Plate No. 419 is the name of a new colloidal material that is said to protect steel, wood, and concrete against wear and to make them skidproof. It can be applied like ordinary paint to surfaces that have been freed of oil, grease, and moisture, and is recommended for coating floors, landings, and stair treads, as well as rock- and ore-handling equipment, chutes, conveyors, coal-mine cars, etc. The vehicle is a varnish in which flakes of stainless steel are carried in suspension. The materials are sold by United Laboratories, Inc., in separate containers for mixing, as required. One gallon, it is claimed, will cover 600 square feet at a cost of approximately one cent a square foot.



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